PARK SCIENCE

INTEGRATING RESEARCH AND RESOURCE MANAGEMENT

WOLF HANDLING ON
ISLE ROYALE

***ECOLOGICAL SCALE* REVIEWED**

PROTECTING RESOURCES
AND VISITOR OPPORTUNITIES

A CONVERSATION WITH POINT REYES
SUPERINTENDENT DON NEUBACHER

VOLUME 20 • NUMBER 2 • FALL / WINTER 2000

UNITED STATES DEPARTMENT OF THE INTERIOR

NATIONAL PARK SERVICE

Restyling
in the century of the environment

Nearly six years have elapsed since the last face-lift given to *Park Science*. The current changes coincide with the new millennium, or what participants to Discovery 2000 last September in St. Louis began referring to as the "century of the environment." The purpose of the changes, however, is based on a practical matter rather than a symbolic one: to compel the interest of new readers, both within and outside the National Park Service, and to stimulate greater appreciation for science-based park management.

About to begin its 21st year, *Park Science* has a devoted audience. Yet we have often wondered who is not reading it and what we could do to induce them to become readers. We even asked a question to this effect in a reader survey five years ago, and we got a few varied responses. Among them were to include more social science articles, feature the recommendations of superintendents, upgrade the science being reported, print both technical and nontechnical articles, provide more information on potential grant sources, help build synergy between maintenance and resource management operations, provide real-world management solutions, and publish on the Web. In many cases we have acted upon these ideas. One suggestion, however, has not been addressed until now: to make this publication more competitive with the many newsletters and bulletins that vie for the attention of readers.

Park Science *through the years: 1981 (top), 1991 (middle), and 1995.*

With impetus from the *Park Science* editorial board and design concepts provided by Glenda Heronema of the Denver Service Center, we introduce a new look for *Park Science* this issue that is more attractive and magazine-like, and thus more friendly and inviting. Gone is the institutional newsletter appearance, replaced by more fully developed pages and the use of color as an enticement to new recruits and devoted readers alike. We sincerely hope the new design will garner attention from those otherwise inclined to pass it by, while retaining the interest of those who have always found it informative. We believe the new look will broaden our reach, increase our ability to nurture science-based park management, and build public awareness and understanding of our resource preservation mission. Please let us know what you think.

Does this signal a change in our message? Essentially, no. *Park Science* will continue to report recent and ongoing research and its application in park management. However, as we begin this century of the environment, we want to be more inclusive of all park operations and plan to modify the Highlights department along these lines. Specifically, we want to feature brief articles that describe what all NPS operations in parks are doing to preserve natural resources and how they are applying science to improve their own operations. For example, we want to share the contributions of maintenance and visitor and resource protection divisions to the accomplishment of natural resource management projects. Likewise, interpretive programs that involve the public and school children in our natural resource management programs through hands-on participation are of interest. We want to feature the views of park superintendents on the role of science in resolving management problems. And, of course, we intend to continue publishing research results that have implications for natural resource management along with reports of the many activities of park natural resource programs across the nation.

As always, we invite you to participate in *Park Science* by submitting your stories and helping us achieve this goal.

Jeff Selleck
Editor

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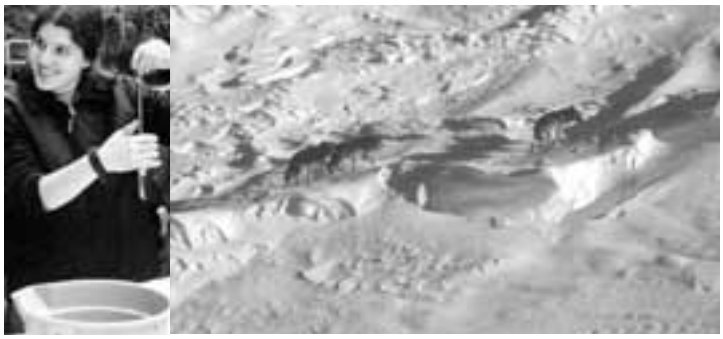

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Cover Story

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ON THE COVER
Wolves travel the icy shoreline of Siskiwit Bay at Isle Royale National Park, Michigan. After having successfully studied wolves and moose on this wilderness island for 30 years without handling, biologists began a live-trapping program in 1988 that provided important genetic information to managers. Last year the park investigated the possibility of returning to a hands-off monitoring approach. PHOTO BY ROLF O. PETERSON

BOOK REVIEW

ECOLOGICAL SCALE
Theory and Applications

By D. L. Peterson and V. Thomas Parker, editors

A book review by Allan F. O'Connell, Jr.

Much of how we care for and manage our natural world this century will revolve around how ecological scale is interpreted. The question of scale—the range of specificity applied in natural resource studies and management—is fundamental and critical for ecologists. Yet application of scale concepts is a complex and contentious area of ecology that is often difficult for resource managers to implement in planning and conservation efforts. Given the enormous amount of material currently available and the difficulty scientists and resource managers face in simply finding all available literature on a particular topic, "Ecological Scale—Theory and Applications" represents an important compilation of information under one cover. For a topic described as "important, poorly understood, and controversial" (another review of this book), this publication should be a mainstay for scientists and resource managers everywhere in need of a thorough and first-rate reference on ecology.

> "This publication should be a mainstay for scientists and resource managers everywhere in need of a thorough and first-rate reference on ecology."

Part of the "Complexity in Ecological Systems" series, Ecological Scale is divided into four sections: (1) integration of process, pattern, and scale; (2) interpretation of multiple scales in ecosystems; (3) ecological inference and application—moving across multiple scales; and (4) incorporating scale concepts in ecological application. The entire volume is 608 pages, with 33 different contributors (some authors participated in more than one chapter) and 72 pages of references. The book is truly interdisciplinary, and the editors have clarified and illuminated the importance of scale in a variety of ecosystem components: animals (including an entire chapter on large mobile organisms), plants, water, food webs, and soils. Additional highlights include scale-oriented reviews of ecological theory, ecosystem management, relationships to policy and decision making, experimental design, and measuring environmental change.

A previous book review in *Park Science* stated "many books on conservation topics have poorly integrated chapters, are hard to read, are often dull, and end up serving primarily as references for a narrow, technical audience" (see volume 18(1):10–12). Some of these assertions may apply to Ecological Scale; browsing the chapters reveals a good deal of complexity in consideration of the many tables, figures, and citations. I had some trouble maintaining focus and interest in some chapters but attribute this to my own particular interests. Nonetheless, given the diversity of topics covered, I found the volume to contain a wealth of important information on how ecologists and resource managers view ecosystems and their various components. Additionally, the book delves into the application of the concepts of measurement, analysis, and inference in both theoretical and applied ecology, essential information for park resource managers.

Ecological Scale—Theory and Applications

1998, Columbia University Press
608 pages

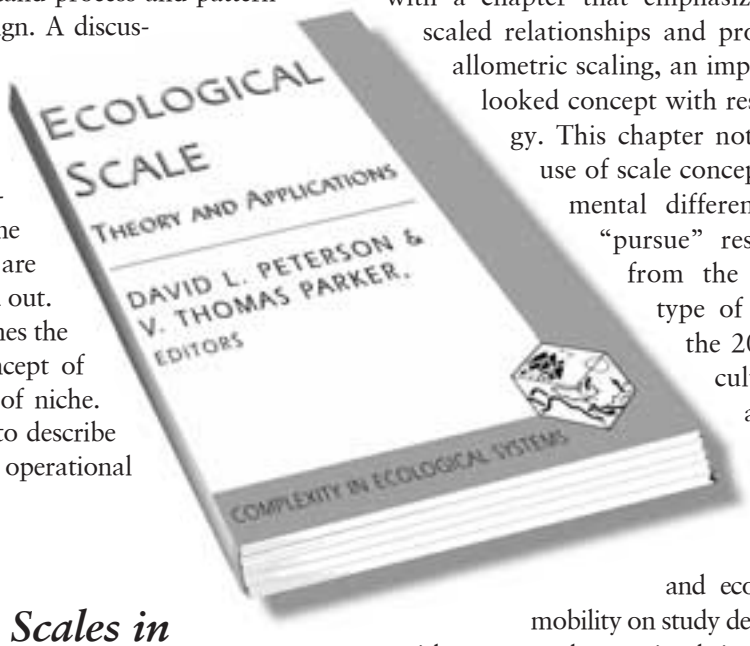
Cloth
ISBN 0-1231-10502-9
$63.00

Paper
ISBN 0-231-10503-7
$35.00

With some humorous, but thought-provoking chapter titles that include "Homage to St. Michael or why are there so many books on scale," the importance of scale in biological systems quickly becomes evident. With the interest of the resource manager in mind, I have attempted to summarize each of the four sections, point out some highlights, and offer a few parting comments.

Section I—
Integration of Process, Pattern, and Scale

The book begins with the aforementioned "Homage to St. Michael…" chapter that discusses the semantics and implications of the terms "scale" and "level" in ecology. This section provides a detailed review of techniques used for detecting spatial patterns including a concise definition of fractals and the need to understand process and pattern as they relate to experimental design. A discussion ensues using landscapes as a backdrop and concluding that the integration and organization of scaled relationships within complex systems will clarify our understanding of the natural world. Some things are scale dependent, others are not, and the differences are pointed out. The last chapter of section I examines the ambiguity that surrounds the concept of habitat and the evolving concept of niche. The Habitat-Based Model is used to describe these relationships and the model's operational framework is presented.



Section II—
Interpreting Multiple Scales in Ecological Systems

A paleoecological perspective compares hypothesis testing versus the description of microscopic plant pollen (fossil) that is the primary source of information about environmental change. The question "How can techniques be used for management applications?" is examined. The discussion then focuses on soils and their resulting spatial and temporal relationships. Criticism is levied on the views ecologists have long held for soil, and the major misperceptions of the soil environment are addressed. The physical environment and biological structure of lakes and riverine systems are reviewed along with the importance of human influences on these systems. The next chapter considers how to examine scale issues in the context of plant community dynamics and the usefulness of hierarchy theory and predictive model development. A well-crafted chapter on animal population dynamics completes the variety of single-system components that are examined, and will likely stimulate integrated work on animal populations in the context of dispersal and landscape structure. The last two chapters focus on food webs (i.e., species richness, trophic or nutritional levels) and landscapes, two topics representative of integrating the components previously discussed.

Section III—
Moving Across Scales: Ecological Inference and Applications

Based on the variety of topics, this section has little continuity, much like the following review. Nevertheless, the topics are important and offer insights into the study and management of large organisms and the use of applied scaling theory to conduct research. The section begins with a chapter that emphasizes the importance of scaled relationships and provides an overview of allometric scaling, an important and often overlooked concept with respect to scale in biology. This chapter notes that the increasing use of scale concepts represents a fundamental difference in how scientists "pursue" research, a move away from the purely observational type of research pervasive in the 20th century. The difficulty with remote sensing and the use of large data sets is complicated by the differences in the meaning of scale to geographers and ecologists. The impact of mobility on study design and interpretation with respect to how animals interact with the environment is directly related to scale. The break point for what is considered a large organism was not defined, but one gets the impression that extrapolation could be made to any size organism. The importance of trees, in particular tree branches, in determining patterns of vegetative change is offered as the scale from which to focus ecological research. The authors give a variety of reasons in support of this approach as opposed to either the leaf- or the entire tree-focused approach. The next three chapters are key for scientists and resource managers alike, given the importance of ecosystem disturbance, study design, and data analysis in conducting and interpreting research. While the discussion surrounding these three topics is overwhelming, the topics themselves are of critical importance if we are to critically examine and understand our resources. Although some topics like time series and autocorrelation are more suited for the scientist, the resource manager striving to keep abreast of the intricacies of the science in their parks would do well to review these chapters.

See "Book Review" in right column on page 7

news&views

Alcatraz Bird Census

Dear Editor,

The article entitled "Alcatraz bird census … or the ABC program" in the spring 2000 issue of *Park Science* [20(1):6] contains several inaccuracies. Ranger Brett Woods did found the Alcatraz Bird Census (ABC) in the early 1990s. However, after his brief stint on the island ended, I took over ABC program management. The program hardly "languished" as the article stated. Instead, it ran successfully until I left the island in 1997.

I worked on Alcatraz from 1991 to 1997. Among my myriad duties, I served as Natural Resources Coordinator for the island. I recruited, trained, and supervised the volunteers that conducted the ABC until I left for Everglades National Park in 1997. During my tenure as "Birdman of Alcatraz," the ABC did quite well. There was no apparent need for changing the census procedures or database management. I was therefore disturbed to note that the article suggested that the ABC stagnated or stopped after Woods' departure.

Wilfredo Reyes
Park Ranger
Everglades National Park

Golden Gate NRA regrets the article's tone. However, the decision to standardize methods for recording bird frequency and occurrence data on Alcatraz along with regular reporting has improved the value of the information. For example, the area search protocol[1], now used on Alcatraz and at other areas in the park, distinguishes birds on land from those on water, information that was useful to park management in a recent environmental impact statement. The technique has other benefits, including its widespread usage. Database management evolved to reflect the needs of the protocol, and the software was changed to meet the NPS standard.

[1]Ralph, C. J., G. R. Geupel, P. Pyle, T. E. Martin, and D. F. DeSante. 1993. Handbook of field methods for monitoring landbirds. USDA Forest Service, Publication PSW-GTR-144, Albany, CA.

Axtell and Vequist take on new challenges

Last spring, Mike Soukup, the Associate Director for Natural Resource Stewardship and Science, announced the selection of Craig Axtell as Chief of the new Biological Resource Management Division. Headquartered in Fort Collins, the new division will help carry out the thrusts of the Natural Resource Challenge to protect native and endangered species and their habitats and to aggressively control nonnative species. The division was funded and established in FY2000.

In taking the new position, Axtell left his job with Rocky Mountain National Park where he served as Chief of the Division of Resource Management and Research. His career with the National Park Service spans 25 years and also includes positions as Park Planner and Economist with the Denver Service Center and Resource Management Specialist at Everglades and Isle Royale National Parks. He graduated from Colorado State University with a B.S. in forest science and an M.S. in natural resources management.

Since coming on board in May, Axtell has been busy setting up Exotic Plant Management Teams to address the problem of invasive plants in parks. Four teams are currently operational and have begun exotic plant eradication efforts at parks in the National Capital Region, Chihuahuan Desert and shortgrass prairie, Hawaiian Islands, and Florida. Other functions of the new division are national coordination of threatened and endangered species management, integrated pest management, technical assistance with animal trapping and wildlife veterinary operations in parks, and advice to parks on other complex biological resource issues.

Also making a switch in jobs is Gary Vequist, who was recently selected as the Associate Regional Director for Natural Resource Stewardship and Science in the 13-state Midwest Region. Duty stationed in Omaha, Nebraska, Vequist formerly served as Chief, Resource Management and Visitor Protection, at Carlsbad Caverns National Park in New Mexico. He replaces Ron Hiebert, who transferred to the Colorado Plateau Cooperative Ecosystem Studies Unit at Northern Arizona University in Flagstaff, Arizona, last December.

Before his assignment at Carlsbad, Vequist held positions as the Alaska Regional Resource Manager for seven years and supervisory resource manager at Glacier Bay National Park, Alaska, for eight years, in addition to numerous other seasonal park positions. He earned a B.S. in zoology from Washington State University and an M.S. in environmental quality engineering from the University of Alaska. He brings to his position broad experience working with species inventorying and monitoring, fire and cave management, visitor protection programs, and scientific research.

Ecosystem valuation website launched

Are you looking for ways to increase the relevance of your park's resource preservation goals and projects in the eyes of park visitors, neighbors, and other constituents? While justifying such programs and actions strictly on economics would be folly, economics should not be ignored and can help managers evaluate which preservation projects to undertake and how to justify their expense. Resource managers may find the website "Ecosystem Valuation" helpful in understanding how economists value the beneficial ways that ecosystems affect people. Written and developed by Dennis King (University of Maryland) and Marisa Mazzotta (Univeristy of Rhode Island), the site is designed for non-economists who need answers about the benefits of ecosystem conservation, preservation, or restoration. It provides a clear, nontechnical explanation of ecosystem valuation concepts, methods, and applications.

The website contains: a discussion of the purposes and context for ecosystem valuation (The Big Picture); a non-technical overview of the economic theory of benefit estimation (Essentials of Ecosystem Valuation); descriptions of specific valuation methods, including both dollar-based measures and nonmonetary measures (Dollar-Based Ecosystem Valuation Methods, and Ecosystem Benefit Indicators); case study illustrations of each method; practical considerations related to the methods, including when each method is most appropriate, and the links to sources of related information (Links); and opportunities to provide feedback and share your experiences as you develop and use estimates of ecosystem benefits (Feedback).

The URL for Ecosystem Valuation is www.ecosystemvaluation.org/. The site is funded by the USDA Natural Resources Conservation Service and the National Oceanic and Atmospheric Administration. PS

"Book Review" continued from page 5

Section IV—
Incorporating Scale Concepts in Ecological Applications

This section describes how managers and scientists can effectively apply concepts of scale to natural resource management. Flow chart (i.e., word) models, tables, and diagrams effectively support the text and illuminate how we use scale to measure environmental change and how scale affects research, management, and most importantly policy. Discussion of policy issues include air pollution and salmon in the Pacific Northwest, fire, and global climate change, each demonstrating a perspective that all resource managers should consider.

> "Highlights include scale-oriented reviews of ecological theory, ecosystem management, relationships to policy and decision making, experimental design, and measuring environmental change."

Conclusion

Covering the complexity of the scale topic, this volume represents an important compilation of information on a topic that is often misunderstood, and one for which little attention is paid (although, thankfully, this seems to be on the decline). Although technical, this book provides full exposure to the scale issue in ecology and is an important reference for researchers and resource managers who are working to understand and preserve ecological function in parks. The authors and editors have combined to provide a needed examination of a very important topic. In summary, why purchase all those books on scale when just one will do? The mountain of information alone stuffed into this one book should prompt all parks to get a copy and have it on hand as a quick and ready reference. PS

About the Author

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HIGHLIGHTS

Students weigh and sample juvenile fish (above, left and right) at Sitka National Historical Park, Alaska, as part of a Nature Watch Program to encourage hands-on experience in scientific monitoring and nature discovery. One student improved the park herbarium, adding 18 species of seaweed, including the one at the right, as voucher specimens.

Students gather data at Sitka

Sitka National Historical Park is located at the mouth of Indian River, which flows through a temperate rainforest in southeastern Alaska. In September 1999, the park started a Nature Watch Program to give middle school and high school students hands-on experience in scientific monitoring and the discovery of nature. Local students and those attending boarding school from remote villages are documenting the state of local watersheds through stream surveys, biological inventories, water chemistry analysis, measuring stream flows, recording types of streambed materials, identifying juvenile fish, and mapping river channels. Students collect these data with help from park biologist Jennifer Williams, park rangers, and volunteers from Alaska Department of Fish and Game (ADF&G), U.S. Forest Service, and the Sitka Tribe of Alaska.

One of the program activities, fish surveys, was conducted throughout the year and provided the students with a valuable hands-on experience in fish identification and handling, data collection, and project organization. The goal of these surveys was to determine the species present and their age class. First, the students learned to distinguish between juvenile coho salmon and Dolly Varden, then they separated the species into designated buckets. If a fish species was unknown to the student, the ADF&G or NPS biologist helped make the identification. Next, three students weighed and measured the juvenile fish and recorded the information. The information will be used to determine how long the fry develop in the stream before migrating to sea.

The program, which ran through last winter, created a new source of data for park managers. The students' fish sampling efforts have resulted in documenting the presence of cutthroat trout, a species previously unknown to raise its young in Indian River. Sampling of junile fish is also helping the park delineate prime rearing locations

for salmon, trout, and char. The information collected will be used to better understand and protect park resources.

Sasha Stortz, a 10th grader, found the park's resources interesting enough to volunteer time throughout the summer. Working on a voucher collection project, Sasha has pressed and added 18 new species of seaweed to the park's current herbarium of 50 species. Later in summer she assisted with production of Web page photo galleries specific to the natural resources at Sitka National Historical Park.

Sitka National Historical Park's Nature Watch Program has brought the park closer to the community, raised awareness of park resources, allowed students to discover more about nature, and offered creative opportunities for individual students. The park will continue to enhance the program through future proposals and community outreach.

Gauging Hoover's fishing hole

Floods and stream flow form the basis of a partnership between Herbert Hoover National Historic Site (Iowa) and the Iowa District of the U.S. Geological Survey (USGS). After flooding in 1993, the USGS assessed flood recurrence on a tributary of the west branch of the Wapsinonoc Creek within the park. The USGS has continued its relationship with Herbert Hoover National Historic Site since that time by installing a National Streamflow Network stage gauge in the park.

The National Streamflow Network of the USGS consists of more than 7,000 gages across the nation. These gauges contribute the data necessary to address water quality and quantity issues. Data appear on the Web at www.usgs.gov.

Herbert Hoover National Historic Site uses the gauge as part of a water monitoring program. Flooding poses a threat to historic resources in the park with a high probability that a 25-year recurrence flood would cause damage to structures. Understanding the behavior of the creek may lead to better prediction and mitigation of damaging floods.

The park also uses the gauge as a demonstration of natural resource management. Interpretive signs and a digital readout of real-time data accompany the gauge housing in a high traffic area of the park. Visitors can read measurements of water temperature, air temperature, rainfall, and stream flow.

Park staff use the stream to help visitors understand that human development has changed water resources in the last two centuries. Wapsinonoc Creek, and its tributary in the park, were very different streams when President Hoover fished them as a boy. Riparian wetlands stabilized stream flow, but development encroached on these wetlands at the turn of the century. Field tiling and additions of impermeable surfaces within the watershed increased the rate and quantity of runoff from storm events. These changes have resulted in flash flooding and bank erosion on the creek.

The stream gauge provides an opportunity to use resource management issues in the park to deliver a broad message about watershed protection and land use. The gauge will provide data for management decisions concerning land use and cultural landscape within the park. Additionally, it will provide the National Park Service with hard science for its leadership role as a public land and watershed steward. PS

Articles wanted

Do you have a story you want to see published in Highlights or another department of *Park Science*? All you need to do is show how a park operation such as resource management, interpretation, visitor and resource protection, or facility management is contributing to the preservation of natural resources in a unit of the national park system through the application of science. Send your submission to the editor (see back cover for contact information) along with a photograph to illustrate your main point. More complete guidelines for submitting all types of articles for publication are available on the *Park Science* website (www.nature.nps.gov/parksci).

Info Crossfile

Visitors, ungulate management, and interpretation

Management of ungulates in the national park system has varied throughout the history of the parks. From 1900–30 attempts were made to increase numbers of ungulates and enhance viewing opportunities. Concern about the overabundance of ungulates was prevalent from 1930–40 and in 1941 through 1968 parks instituted control programs to limit ungulate numbers. Since 1970, when activist citizen groups emerged, public involvement in environmental decisions increased drastically. Because they want to view animals and preferably at close range, visitors have an interest in the management and welfare of wildlife in parks.

However, surveys revealed that the American public has a poor understanding of ecological concepts and therefore as difficulty in the comprehension of resource management in parks. Examples are the opposition of the public to removal of the mountain goat from Olympic National Park (see photos) where this species is considered alien and the discontinued removal of exotic burros from the Grand Canyon.

R. G. Wright, writing in the Wildlife Society Bulletin (1998. A review of the relationships between visitors and ungulates in national parks. No. 26(3):471–76), suggests that interpretive programs in parks could play a more important role in educating the public about sound park-specific management of ungulates. Park interpretive programs could be strengthened if they regularly included (1) explanations of the effects of land-use adjacent to a park on the park and its wildlife, particularly migratory species; (2) explanations of the environmental, cultural, or ecological function of resource management; and (3) briefings on and explanations of impending management such as control of alien species or culling of overabundant animals.

Meeting the public's desire to see wildlife in parks without creating disturbance of the animals and without inviting well-meaning but inappropriate reversal of management is challenging and calls for innovative techniques. Because of budget limitations and fears of visitor dissatisfaction, some parks seem reluctant, for example, to have visitors leave their vehicles and use public transportation to reduce disturbances of wildlife but increase viewing. (An exception is Denali National Park, which tightly controls private vehicle use on a 130-km road; most visitors use public transportation.) Wright suggests that increasing public understanding of wildlife management in parks may be the only alternative of meeting the objectives of protecting wildlife in parks and retaining the support of the public. Visitors must be made to understand that parks were established as sanctuaries where animals can live in nature but are not to be placed on display, and that management of a park must be toward that end.

Wilderness management survey

A variety of programs designed to foster personal development or treatment of various ailments offer wilderness experience to paying clients. The programs are held in designated units of the National Wilderness Preservation System and on other public or private lands that offer naturalness and solitude. The excursions have social benefits for the clients but may pose a threat to the very wilderness that inspired them.

Preventing adverse effects by wilderness programs is already a grave concern in many areas, but information about such effects was not available until four investigators began a study and collected data about the attitudes, policies, and concerns of wilderness area managers (Gager, D., J. C. Hendee, M. Kinziger, and E. Krumpe. 1998. What managers are saying—and doing—about wilderness experience programs. Journal of Forestry 96[8]:33–37). The researchers sent eight-page question-

naires about policies, attitudes, concerns, and preferred solutions of problems to the supervising administrators of 151 units in the National Wilderness Preservation System: 78 national forests, 49 units in the National Park System, 6 BLM state jurisdictions, and 18 national wildlife refuges. They excluded islands and areas smaller than 5,000 acres where overnight use by wilderness experience programs was unlikely. They received responses about 144 (95%) units.

Two-thirds of the mangers felt that the use of wilderness in their areas of responsibility was increasing. More than a third thought use was growing 25 percent per year or more. All the agencies required permits for use by wilderness programs. Almost a third (29%) of the managers felt that their agency policy was not sufficiently restrictive; most (67%) thought theirs was just right; some (4%) thought theirs was too restrictive. Managers in the USDA Forest Service and the National Park Service tended to think their agency policies were not sufficiently restrictive. Bureau of Land Management and U.S. Fish and Wildlife Service managers thought their policies were just right. As many as 31 percent of the managers suggested that their current policies were too ambiguous or incomplete or that they did not know enough about the number or types of wilderness programs using their areas. Another third reported that their policies either were under revision to be made more restrictive or wished their policies would be revised.

The gravest reported problems created by wilderness experience programs were establishment of new trails and sites, overuse in already saturated areas, site impacts, large group size, lack of wilderness stewardship skills and knowledge, and conflicts with other recreation users. Managers favor programs that promoted understanding and caring for the wilderness resource over programs that emphasized challenge, adventure, and personal growth. Almost a third of the managers think the programs conflicts with other users. Managers want higher standards and better compliance with regulations, certification of program leaders, and liability insurance. Managers recognize the benefits of the program to the participants but do not think that the programs are wilderness dependent.

The survey revealed that communication and coordination among agency managers and wilderness experience program leaders are needed to avoid misperceptions and differences, and minimize the adverse effects by the programs, namely, to secure the benefits of wilderness for present and future generations.

Selecting Biological Indicators for Resource Monitoring

Heavy visitor use in parks can cause unacceptable deterioration of resources such as soil compaction, soil loss, vegetation loss, disruption of normal nutrient cycles, changes in hydrologic cycles, and changes in animal populations. To identify biological indicators that measure visitor effect and response of resources to management, Arches National Park developed a Visitor Experience and Resource Protection (VERP) plan that prescribes five steps (Belnap, J. 1998. Choosing indicators of natural resource condition: A case study in Arches National Park, Utah, USA. Environmental Management 22[4]:635–42). (1) Identified are vegetation types that visitors use most. Compared are samples of vegetation and soil in affected and unaffected sites. (2) Variables that differ significantly between the compared sites are used as potential indicators. (3) Site-specific criteria for indicators are developed with information from previous studies and local experience, and potential indicators are evaluated with the criteria. (4) The selected indicators are further examined for ecological relevance. (5) Final indicators are selected and field-tested, and monitoring sites are designated.

Indicators for monitoring annually in Arches National Park were a soil crust index, soil compaction, and the number of used social trails and soil aggregate stability. Indicators for monitoring every five years were vegetation cover and frequency, ground cover, soil chemistry, and plant tissue chemistry. For monitoring, Arches National Park was divided into zones that reflect various types and

levels of visitor use. In these zones, sites that were affected most by visitors were monitored under the assumption that these sites would best indicate compliance in the rest of the zone. Monitoring sites were changed with changes in visitor use.

The approach to indicator selection in Arches National Park was time- and cost-effective. The identified indicators were better than genetic indicators for different habitat types, geographical locations, or use levels. The process was effective for defining acceptable resource conditions for different levels and types of recreation and for providing management with clear, quantified directions. Weaknesses of a plan like VERP are (1) the need for lead time (2 years or longer) to survey habitats, develop a list of potential indicators, determine ecological relevance, and field-test the indicators; (2) staff expertise for the assessments; and (3) time and money, constraints of which may necessitate that measured variables are limited to those that are clearly visible, inexpensive, and easy to measure. The tiered approach of measuring some variables annually and other variables less frequently may be an acceptable response to time and money constraints.

Global warming favors invasive species

Elements of global change include change in atmospheric composition, greenhouse-gas-driven climate change, increasing nitrogen deposition, and changing patterns of land use that fragment habitats and alter disturbance regimes (Dukes, J. S., and H. A. Mooney. 1999. Does global change increase the success of biological invaders? Tree 14[4]:135–39). These elements can affect species distribution and resource dynamics in terrestrial and aquatic ecosystems. They can favor groups of species that share certain physiological or life history traits. New evidence suggests that many nonnative invasive species are favored by conditions from recent global change. An increase in the abundance of such species may alter basic ecosystem properties. For example, many invasive nonnative plants such as cheatgrass, kudzu, and Japanese honeysuckle are favored by elevated levels of CO_2. The stimulated plant growth from elevated levels of CO_2 may increase fuel loading and under the right conditions increase the frequency and severity of fires. Information from experimental studies suggests that rising CO_2 levels may slow the process of succession in grasslands and thereby increase the dominance of nonnative species in many ecosystems. Most plants increase their water-use efficiency if grown in CO_2-enriched environments. If under such circumstances the rate at which plants transpire decreases, the soil beneath plants dries out more slowly and where plant growth is limited by water, species that can take advantage of the extra moisture may eventually prevail. The abundance of a native species, Hayfield tarweed, in California seems to have increased from such circumstance. But so did seemingly the invasive yellow starthistle. The effects of elevated CO_2 levels are however not readily predictable because they may depend on other factors such as local resource availability, photosynthetic pathways of species, and competition by other species.

Global warming from greenhouse gases is expected to be most intense in winter at high northern latitudes. Changes in global temperatures are also expected to change precipitation regimes. Again, experiments revealed that under some circumstances a short-term increase in water availability can affect the long-term establishment of nonnative species even after treatments are discontinued. Long-term observations revealed that an increase in annual precipitation in arid and semiarid regions of western North America could increase the dominance of invasive nonnative grasses. On the other hand, global warming may decrease or shift the range of some nonnative species.

Observations suggest that climate change will affect interactions among native and nonnative animal species. For example, higher temperatures will favor the Argentine ant to the detriment of native ant species and will decrease habitat for cold, cool, and even some warm-water species. Warm-water nonnative organisms that may expand their ranges are the cane toad, largemouth bass, green sunfish, and bluegill. Generalists that unlike specialists do not depend on specific conditions will adjust better to changing environmental conditions. Invasive species are usually generalists.

Nitrogenous compounds that are released into the atmosphere by fossil fuel combustion, fertilization of agricultural fields, and other human activities return to the surface in precipitation and dry deposition and fertilize a large and growing portion of the terrestrial biosphere. Such nitrogen deposition disadvantages slow-growing native plants that are adapted to nutrient-poor soils but favors faster-growing plants such as grasses. The increase of nitrogen deposition has already altered the species composition of heathlands and chalk grasslands in the Netherlands. Nitrogen deposition may also have already allowed the invasion of California coastal prairie by introduced annual grasses.

Research is required to better predict the effects of global climate change on plants and animals. Experiments must be designed that simultaneously reveal the effects of global change on specific nonnative species and answer general questions about invasion biology. PS

Meetings of Interest*

March 16–20, 2001

The Wildlife Management Institute is sponsoring its 66th North American Wildlife and Natural Resources Conference this spring in Washington, D.C. The conference will explore improvements in the management of species of concern, the role of hunting in wildlife management, and the relationship of large-scale environmental factors (e.g., global climate change, human population growth and sprawl, and acid precipitation) on the ecological well-being of the continent. Other conference tracks will look at issues related to the conservation of the Chesapeake Bay watershed and wildlife habitat conservation on private lands. Further information is available at www.jwdc.com/wmi/.

April 16–20

The George Wright Society Biennial Conference on Research and Resource Management in Parks and on Public Lands will convene in Denver, Colorado, and explore the theme "Crossing boundaries in park management: On the ground, in the mind, among disciplines." One of the great lessons of the last 20 years has been that parks and park-like places can no longer be managed strictly from within. Undeniably, managers must focus outwardly and routinely engage local communities, partners, and the public in dialogue about park management. Thus, the conference will focus on effective land management in the context of crossing boundaries related to jurisdiction, in our minds, and those that keep us too narrowly focused in our own areas of expertise. David Lowenthal, eminent geographer, biographer, and expert on the perception and meaning of history, will keynote the conference opening session. Environmental philosopher and award-winning nature writer, Kathleen Dean Moore, will also address participants during the week. Further information is available at www.georgewright.org or by calling 906-487-9722.

April 24–26

The Department of Defense is hosting the International Military Noise Conference in Baltimore, Maryland, to address concerns about the continued growth of noise pollution. Participants will include military personnel, environmental officials, and industry and citizen stakeholders with a vested interest in the effects of two types of military noise: environmental and occupational noise. The gathering will provide a forum for the exchange of information on military noise; the associated effects on humans and wildlife; and current, future, and emerging technologies. Further information is available at www.apimeetings.com/.

May 27–June 1

The Society of Wetlands Scientists extends a welcome to everyone who is involved in wetland science, research, protection, management, education, and policy to attend its 22nd Annual Meeting in Chicago, Illinois. Now in the planning stages, the conference will center on wetlands in an urban setting, which provide critical functions in the landscape and provide a key link between large centers of human population and natural resources. Further information is available at www.sws.org/chicago/.

*Readers with access the NPS NR Intranet can view a comprehensive listing of upcoming conferences and meetings at www1.nrintra.nps.gov/ (click "conferences, meetings, and training").

How long do we keep handling wolves in the Isle Royale wilderness?

By Jack G. Oelfke and R. Gerry Wright

Sometime during winter 1948/49, what is now Isle Royale National Park's most famous inhabitant, the gray wolf *(Canis lupus)*, entered the Michigan island, crossing the ice-covered Lake Superior from mainland Ontario or Minnesota. Upon their arrival, they discovered what must have been to them, quite simply, *paradise*: an island with plenty of food *(Alces alces,* the moose) and no human harassment. No roads, no hunting, and no serious competition for the ample prey base present. The wolves made quick work of their only true competitor, the coyote, by eliminating it from the island within a few years. More importantly, they asserted an influence over a moose population whose numbers had fluctuated considerably since its arrival to the island ecosystem in the early 1900s, including at least one massive population crash in the 1930s.

Ten years later another significant lake crossing occurred—the arrival of the first researchers into the park to begin a focused study of the wolf population. In 1958 Dr. Durward Allen and his associates began what has become the longest-running wildlife study in the world, the wolf and moose research and monitoring study in the park. By winter 2000 this study had reached its 42nd year, including the last 30 years of investigation under Dr. Rolf Peterson of Michigan Technological University. The research brought to the world a look at wolves and moose in an ecosystem largely free of the ills and influences of modern society. In doing so, these efforts made the wolf famous, the icon of Isle Royale itself. The park, and the stature of the gray wolf in America, has forever changed as a result of these two journeys.

> Despite the years of intensive study, the wolves were never handled or touched by humans.

Background

The popular media began its role in creating a near mythical status for the island's wolves as early as 1963 in *National Geographic* (Allen and Mech 1963). A part of the mystique that surrounded the wolves of Isle Royale was that despite the years of intensive study, the wolves were never handled or touched by humans. Even prior to the park's wilderness designation in 1976, park management directed that no handling of wolves would occur through the research efforts. Adequate documentation of the status and trends of the wolf population could be gathered through aerial surveys in the winter (see the cover photograph), and for the first 30 years of the study, that was enough intrusion in their world. The policies and philosophy of designated wilderness, which direct that the minimum requirement or tools be used when completing any action within wilderness (including approved research), influenced this decision, but so did the desire to perpetuate the aura of the untouched wolf population.

By 1980 the island's wolf population stood at 50, an incredible density of one wolf per four square miles. This density was not sustainable, and when the wolf population crashed to 14

Figure 1. Three biologists carry a sedated wolf to an examination site at Isle Royale National Park. Looking for answers to a wolf population crash due, in part, to disease, biologists began live-trapping and handling wolves in the park in 1988. PHOTO BY ROLF O. PETERSON


ONTARIO
17
Thunder Bay
Isle Royale National Park
17
CANADA
Grand Portage NM
UNITED STATES
Grand Portage
Copper Harbor
MINN
61
41
LAKE SUPERIOR
Sault Saint Marie
53
Houghton
26
2
Duluth
28
28
75
2
Superior
MICHIGAN
35
WISCONSIN
45
2

animals by 1982, no one was terribly surprised or worried. By 1988, however, when the wolf population remained in the low teens despite an apparently ample food base, it was clear that something was awry in the population. Park management sought advice from both within the National Park Service and the external research community, and a peer-reviewed proposal in 1988 recommended the need to handle wolves on the island to assess the persistent wolf population decline and the high mortality rate. The practice of handling wolves continued following a meeting of specialists that reviewed the first-year findings. During that period, no end-date for how long the handling was to continue was discussed; rather, most experts involved believed that answers to the questions of the wolf decline would be gained quickly and resolve the issue. Ultimately, disease as a major factor in the island's wolf decline was implicated in the persistent decline (Peterson et al. 1998).

A peer-reviewed proposal in 1988 recommended the need to handle wolves to assess the persistent population decline and high mortality rate.

Handling the island's wolves also led to greater insights of issues related to wild canid populations. Genetics testing of these wolves led to the understanding that virtually every island wolf had descended from the single maternal founder, and that the population was thus highly inbred (Wayne et al. 1991; Lehman et al. 1991; Peterson et al. 1998). As such, we now recognize that the wolves of Isle Royale provide an unprecedented opportunity to determine the significance of genetic losses for long-term viability in small, isolated populations, one of the major tenets of conservation biology.

Wolf handling continued throughout the 1990s (figures 1, previous page, and 2). The population remained low until a significant upturn started in 1994, and by 1999 the population was near the long-term average since the study had begun (25 animals). Handling continued primarily to assess the health of the population and to obtain genetic information from individual wolves.

Values associated with the wolf research program

The National Park Service recognizes several positive outcomes of the long-term wolf research program. Park management has made several substantive decisions based on the research findings and needs, including (1) a complete park closure to visitor use from November 1 to April 14 each year, largely to facilitate the research program and prevent harassment of the wildlife through winter recreational activity; (2) probition of overnight camping in approximately 50% of the park to protect wolf denning sites and to keep visitors from coming into close contact with wolf pups, thus preventing habituation to humans; and (3) a prohibition of mammalian pets on the island to reduce the potential for disease introductions.

Other recognized values of the research program have included the wide dissemination of natural history information on the wolf and moose populations of the park, particularly as it has described these populations in an environment free of human harassment and interference. An adoring global public now awaits the annual updates of these populations.

Finally, 30 years of population data provided a compelling argument that significant change had occurred, and when wolf numbers dropped so low in the late 1980s more intensive investigation was warranted. This database enabled park management and the research community to assess the need for intensive handling of the wolf population.

Wilderness values in the park

The remote location and difficulty in accessing the island has protected Isle Royale from excessive development and recreational use. Many of the recognized values of wilderness—opportunities for solitude, unconfined recreation, a landscape largely devoid of the human imprint—are found at Isle Royale. Recreational activities commonly associated with wilderness, including backpacking, kayaking, and canoeing, represent the largest user groups of the park.

Isle Royale represents a wilderness landscape unique in North America. It is a landscape with no adjacent terrestrial land boundaries (figure 3) and thus avoids the conflicts of neighboring land management practices, political

Figure 2. Biologists draw blood from a female wolf before outfitting her with a radio collar and returning her to the wild. From 12 years of handling like this biologists have learned that the wolves of Isle Royale are descended from the same founding female and are highly inbred.

PHOTOS THIS PAGE BY ROLF O. PETERSON

considerations, or the immigration/emigration of wildlife, which often heightens the need for management of the wildlife resources. This isolation is a critically important distinction for this park and its wildlife populations. It allows a hands-off approach to wildlife management to be employed, wherein manipulation or intervention—even to the point of strictly nonintrusive research and observation—are minimized to the greatest extent possible, and justified because of a concern for wilderness values. It also allows for consideration of keeping wildlife populations completely untouched by humans, as a baseline of *wilderness* wildlife management at one end of the wildlife management spectrum.

Could the wolf research program return to a hands-off monitoring approach?

Assessing the issue

With the wolf population resurgence on Isle Royale has come the need to ask if we need to continue to handle wolves. For 30 years the park obtained the necessary research information it needed without handling wolves; given wilderness concerns and concerns for the health of those wolves that are live-trapped, could the research program return to a hands-off monitoring approach? Or does the research information now being collected as a result of wolf handling, particularly genetics information, outweigh the live-trapping risks and potential conflicts with wilderness values?

To resolve this dilemma, the park and principal investigator agreed to convene an independent scientific panel to assess the issue and recommend a course of action to the National Park Service. This panel could provide an objective and scientifically valid opinion on the merits of continued handling. The scientific review followed the suggestions outlined by Meffe and others (1998). The panel convened in April 1999, and consisted of three experts (two from the USGS Biological Resources Division, one from the Aldo Leopold Wilderness Research Institute), with participation from NPS employees and the project's principal investigator, Dr. Rolf Peterson. Panel members were selected based on expertise in wolf research and wildlife management and familiarity with wilderness and wildlife management in the national park system.

The expert review panel was asked to review pertinent information on the Isle Royale wolf population and the wilderness values associated with the park and provide a recommendation to park management on the following issues:

"Given the past and current wolf population status in the park, anticipated future research needs, and the wilderness designation of the park, is it necessary to continue to livetrap and handle wolves on the Island? Or can the research and monitoring program return to a non-handling monitoring approach? Have we answered the important questions through the handling of wolves over the past 10 years?"

Results and summary

The panel reviewed the relevant issue information and identified the advantages of handling and not handling wolves as a means to determine a recommendation. That information, with a recommendation, was submitted to park management in a summary report (Oelfke 1999).

Although there are numerous advantages of handling wolves in terms of the quality and quantity of information that can be obtained, the most important advantage identified was that handling permitted the ongoing assessment of genetic change within a small population. This assessment is considered to have broad regional or global application and significance for isolated populations. The key advantage to not handling wolves, aside from the obvious removal of possible trapping injury or mortality to the wolves, was the value of minimizing human influence on the population. The return to a policy of not handling wolves would maintain the park as a baseline of wilderness wildlife management.

Five possible strategies were considered by the expert panel for wolf handling in the park, ranging from no handling to increasing the amount of handling to enhance the research program. As discussion of the strategies continued a consensus was reached that the value of tracking the loss of genetic diversity of this population warranted the continued handling of the population; it then became a matter of selecting a strategy that best addressed the wilderness concerns and research information needs.

Figure 3 (above). With no adjacent terrestrial neighbor, Isle Royale National Park requires management that considers its pronounced wilderness value, including the appropriateness of handling wildlife for research purposes. In the near future, genetics information from wolves may be obtained from their droppings, potentially making further handling of the species unnecessary. PHOTO BY ROLF O. PETERSON

Recommendation

The expert panel recommended:

1. Continue handling wolves for the next five years (2000–2004). Up to four wolves per year should be handled, not to exceed two collared wolves per pack, and no more than 12 wolves total over the five-year period (this is close to the capture rate from 1988–93, but allows more flexibility each year). These numbers reflect the desire to maximize handling opportunities during live-trapping efforts, given the logistical difficulties of trapping operations in the park, while still handling only the minimum number of animals necessary for information purposes.

2. Over the five years, aggressively look for data gathering techniques that would not require handling, by challenging the National Park Service and the scientific community to develop and study these new techniques.

3. If, within the five years, new techniques are found for acquiring genetic data without handling the wolves (e.g., such as scat and hair analyses), convene a panel to evaluate whether disease and population counting benefits are worth the continued handling of wolves.

4. If no new techniques are found within the five years, convene a panel to reevaluate the handling issue.

5. If a sudden population crash occurs, explore different strategies that may be needed to respond to the situation.

The park's response

The use of an expert review panel provided the two parties closest to the issue—the Park Service and the principal investigator—an opportunity to step away from the debate and obtain guidance relevant to the issue. Although, ultimately, the final decision on whether to continue wolf-handling practices rests with park management, the independent scientific review provided an unbiased recommendation for consideration.

Park management has largely adopted the panel's recommendations, with the exception of being unwilling to permit the live-capture of more than two wolves per year, reflecting a very conservative attitude intended to minimize possible injury to individual animals (Barnard 1999). The key information needs critical to the research program will remain obtainable.

The park is also aggressively seeking funding for research that will test whether wolf hair and fecal material can be used for tracking the genetic information needs of this population. Recent projects involving similar techniques for grizzly bears and lynx hold promise that these techniques may apply to wolves, ultimately diminishing the need to handle wolves.

For the near term at least, wolf handling will remain an important element of the wolf research program. Meanwhile, the challenge of balancing the wilderness values of a wild wolf population at Isle Royale with the agency and research needs will continue to provide a fascinating case history for review. PS

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A CONVERSATION WITH
Point Reyes Superintendent Don Neubacher

By the editor

Popular with staff, passionate about natural resource management, and savvy about science, Don Neubacher is a park superintendent for the century. With an undergraduate degree in environmental planning and management, he set out on a National Park Service career that took him initially to Glacier Bay National Park, Alaska—then a national monument—then to Point Reyes National Seashore, California, as a seasonal employee. Following his pursuit of a Master's degree in resource management and a teaching stint at Humboldt State University, Neubacher became the Chief of Visitor Services at Point Reyes. Later, his planning skills were put to the test during a four-year assignment with the Denver Service Center working on the general management plan for the Presidio. After serving as Deputy Manager of the Presidio, he became the Superintendent of Point Reyes in 1995. Regional Director John Reynolds describes him as a "leader in everything that has do with resource management and science in parks." Winner of the 1998 regional superintendent of the year award, Don is co-chair of the Natural Resource Challenge implementation committee. The affable superintendent sat down with the editor recently for a conversation about the use of science in park management, the Natural Resource Challenge, and the future of resource preservation at Point Reyes.

Q. In his book *Preserving Nature,* Richard Sellars detailed an appalling historical lack of park management based on science and ecological awareness within the National Park Service. Are we making any progress?
A. I honestly believe a change is occurring. A lot of the newer superintendents are coming from a broader selection pool. I and a couple others in the Pacific West Region come from a resource management background, and that is somewhat atypical. I think more and more of this is occurring, and it brings a different perspective. Over time—if we continue this—we can start managing a little bit differently.

Q. How?
A. Our decision making is a lot more complex than before. More people are knowledgeable about park resources and park values, so that you have to make decisions these days that are based on science or some background that gives you a footing to make decisions correctly. In the past we made decisions primarily towards visitor services, tourism, and on the politics of the moment. I think we're heading towards ecosystem management decisions based on science. The complexity of our society today dictates that. But the second thing is that the Park Service has evolved. Before, most of our money went into visitor services and maintenance, activities that really weren't perpetuating the natural integrity of Point Reyes. Now, because we have a professional resource program, many superintendents talk about ecosystem management, ecological principles, and making sure the ecosystem is intact over time. That's changing now, although it's not easy to accomplish internally.

Q. Give me an example of scientifically informed resource management at Point Reyes.
A. We just restored native Tule elk to the park's wilderness area. When we started the process we were blown out of the water at our first public meeting—I mean, there was very little support. The community wanted us to back up and get good information. So we collected three years of data, and when we came forward with a new plan based on good science, good population dynamics, and good information, we quickly went through the public process. The elk are restored to a wilderness area now and with a lot of public support. There is a major difference if you have good information that can actually back up what you're trying to accomplish.

Q. What specific information was helpful?
A. The public wanted information on population dynamics, disease, and future population control, if necessary. Our experts overcame some of the concern about elk moving out of the park by sharing their research on elk home ranges, which showed that the animals were fairly sedentary. So far, so good. They're staying where we thought they would. We spent about $300,000 trying to get the information so that we could overcome those obstacles.

Q. Point Reyes is a good example of a park that exists in a complex landscape of multiple jurisdictions, in-holdings, infrastructure, and bordering communities. How do you grapple with that?
A. Clearly, management of Point Reyes cannot be done in isolation. We have two national marine sanctuaries offshore, the State Department of Fish and Game, the Marin

Open Space District, and the water districts; we're even adjacent to Golden Gate National Recreation Area. Altogether, we manage about 90,000 acres in Marin County, which is a fairly progressive and very environmentally aware community. The problem with Marin, however, is that it's adjacent to the San Francisco Bay Area, which has 7,000,000 people and is projected to grow to 9,000,000 by 2030.

Q. What are the implications for Point Reyes?
A. When you look at this regional system, you see major problems ahead. Currently, a big corridor called Highway 101 is being developed all the way up to Santa Rosa. If you look 30 or 40 years down the road you see that we are getting cut off, that there's severe habitat fragmentation. There is not good statewide planning in California or even good county planning. I think in the future, having good science is the only way we're going to be able to move forward in a systematic and strategic way to save the park's integrity over time.

Q. In October 1995, you had a serious fire in the park. What was the park's experience with this?
A. The Vision fire occurred up on Inverness Ridge by Mount Vision. For us, it was a massive fire, about 13,000 acres. It started just outside the park by an illegal campfire on state parkland. Because of the urban interface with this park, the damage to adjacent housing in the wildland-urban interface was really phenomenal—$50,000,000 worth of damage. The interesting part about the fire is that while it was a human disaster, there was very little damage to the natural system. For example, we have a Bishop pine forest, which is a fire-prone pine. The fire removed a lot of the adults that were about 30 or 40 years old, but now they're replenishing. In my mind, the fire helped make the system healthy, and that's pretty much what the science has shown us. We have been completing extensive research since the fire occurred.

Q. Were there any negative resource impacts?
A. A subspecies of beaver called the Point Reyes mountain beaver is experiencing a very slow recovery time. That's about the only thing that still lingers as a negative event. As a matter of fact, nesting success among birds was higher. Monitoring after the fire has shown that most natural systems, even some of the endangered plant species, have responded positively to the fire.

Q. Didn't the fire suppression effort cause concern for the welfare of certain resources?
A. Yeah. We had bulldozer lines and some watershed issues that needed attention. We brought in the Burned Area Emergency Rehab Team to respond to the work that the firefighters had done. We got funding over a two- or three-year period to do the rehab. They also helped us work with the public. Because they were so professional, so good, and knew exactly what they were doing, the team helped build confidence in the community about the National Park Service's ability to respond to fire and rehab after fire.

Q. How did that event affect fire management in the park generally?
A. It focused the attention of the public on the potential good of fire in terms of hazardous fuel reduction. And it also made them realize that you can survive a fire, too. Today that has really paid off because we are updating our fire management plan. We burn maybe 500 to 1,000 acres per year. Before the Vision fire, I don't think we would have gotten any public support for prescribed fire. Now we get tremendous public support. And we learned a tremendous amount, too, in terms of regeneration.

Q. Your elephant seal population is increasing. Why is this a concern?
A. Elephant seals are a great conservation success story. They were driven to the brink of extinction and were restricted to one island off Mexico. Over time, they've recolonized the California coast. We got our first pup, I believe, in 1980. We now have a population that's growing and is currently between 1,500 and 2,000. They haul out during the wintertime, pup their young, and molt. We have tremendous habitat for them, dunes and open beach, and a productive system offshore. So there are good food sources nearby. We're not sure, but the population could grow to 10,000 seals. We have two sites that they use a lot—the headlands of Point Reyes and Drakes Beach—but they're starting to colonize Point Reyes Beach. And the question is: How willing is the public to give up their beaches to elephant seals?

Q. Has it gotten to that point yet?
A. No, but it's just around the corner.

Q. How are you preparing for the inevitable confrontation?
A. We're trying to build support through our educational outreach and elephant seal docent programs, but there are definitely some management problems ahead. It takes time to grow public acceptance that elephant seals deserve to have this beach. Dr. Sarah Allen, the park's Science Advisor, has done a phenomenal job of collecting information on the elephant seal populations, monitoring them, and observing their population dynamics. We can share this information with the public and build a constituency for the seals over time, till people are willing to give up a beach space.

Q. Your resource management staff has grown during your tenure. Is it adequate now?
A. When I came on board, there wasn't a Division of Resource Management; it was a component of the Ranger Division. There were only two full-time resource managers and maybe a seasonal. Since then we've gone up to almost 20 FTEs [or full-time equivalents] and they're doing superb work. We've created a Resource Management Division and a Division of Science and Research. We've hired a wildlife biologist and a plant ecologist. We have active vegetation management and habitat restoration programs. Sarah is doing good work with outside institutions. We probably have, right now, 60–70 research projects being conducted by outside insti-

tutions. We also have significant cultural resources, so we've created a Cultural Resource Division. They're just in the beginning stages. So we're in pretty good shape.

Q. How did you fund the increases?
A. You have to get on the regional priority list, which gets combined at the Washington level in the budget proposal. We argued very strongly that Point Reyes had significant resources. We've got 23 federally listed species in the park and we needed a professional staff to do the job well. We've gotten a couple base increases for the resource program. We also received some outside private funding and reallocated park funds.

Q. How did you foster interdivisional support for building up resource management?
A. After the Vision fire we spent time going through a strategic planning process. We set some overall park goals, vision statements, and everything else. It probably took us a year to get through that process. But it brought all of the divisions around to our primary mission, which is preservation of these resources, the nation's heritage, for eternity. Are some staff feeling that the resource divisions are getting most of the funds these days? Yeah, for sure. However, they were the smallest division for so long; they're just finally catching up. You know, it takes a lot of work on the superintendent's part to make sure that all divisions are feeling good about these overall goals and feel part of the team and get rewards, too, when there is additional funding.

Q. Do other divisions get involved in resource management?
A. Yes. During the Tule elk project, we had a major effort with helicopters to capture the elk and relocate them (see photo this page). We invited the administrative staff to certain events because they were doing the contracting. Obviously, law enforcement was very good at keeping areas closed when we were moving elk. Maintenance blindfolded the elk and assisted in the processing. It takes a lot of muscle to lift the animals into the processing area so we could do the blood testing. So maintenance literally wrestled with these elk as we processed them, and they did a great job. All divisions participated, including me. I was out there helping to hold down the elk and moving them into the horse trailer so we could take them to the relocation site.

Q. Was interpretation involved in the elk project?
A. Yeah, they were on site and did great public information officer work. We needed a strategic effort to get information out to the public. They've done everything from publications to integrating information into their programs, displays, and exhibits on site. They've also helped us build a strategy to inform the public on other critical resource management issues—elephant seals, wilderness issues, and coho salmon—and have done a wonderful job.

Q. Describe your relationship with Sarah Allen, your Science Advisor, and Bill Shook, your Chief of Resource Management.
A. First, I want to say that we have a superb management team overall, and Sarah and Bill are core members of that team. I use the advice of Sarah and Bill almost on a daily basis, and that's why I don't like the idea of centralizing this expertise. They need to be on site near the resources so that superintendents have this expertise available to them on a daily basis.

Q. Most people believe that, certainly.
A. We've got to have those people standing next to superintendents to make sure we at least have good information and make the right decision at the right time. You still have to have political will to do the right thing, but overall, if you don't have information, don't know the options, and are not doing good compliance, then you're potentially making some big mistakes long term.

Q. Your region has established several science advisor positions in the past few years. I think you recognize how technical assistance needs to be easily accessible.
A. As a superintendent, I don't see how we could live without individuals like Dave Graber at Sequoia—I mean, he's phenomenal in terms of his knowledge of the Sierras. And Gary Davis at Channel Islands is recognized internationally for his work on marine systems. Sarah is well known because of her expertise in the Gulf of the Farallones on bird distribution and elephant seals, and all the productivity that occurs out there. I'm just hoping that the Park Service will continue to build a cadre of these great minds that can give us really good information and lead the nation in terms of how we should accomplish research not only in the parks but also in the regional context. Because we need partners and I think this approach is very complementary to BRD, [the Biological Resources Division of the U.S. Geological Survey]. We all need to work together to get the science we need to properly manage these important national resources.

Q. Who are some of your primary research partners?
A. We have a BRD field station at Point Reyes and Gary Fellers is integral to the park management team, too. He's internationally recognized for his work on amphibians, including red-legged frogs. Judd Howell at the Western Ecological Research Center at Sacramento State University provides us other expertise. We also work with Stanford and have great connections with the University of California Bodega Marine Lab and Tiburon Marine

Lab operated by San Francisco State. Sarah has brought all this expertise together.

Q. How so?
A. Sarah knows the options and she speaks the right language with the universities. She probably has five graduate students working for her now. This year alone, because of her expertise in bringing talent to the area, we have probably leveraged a half-million dollars of research that we're not even paying for. We just give them access to the resource and assistance to get the work done. Having Sarah to get these people in and do good research has been phenomenal in terms of getting stuff done.

Q. It sounds like you're describing a function of the learning center network, which is in development across the country. Tell us about that.
A. There are two major concepts behind the learning center. One is that you get researchers on site and give them the essentials: a laboratory, a classroom, office space, and access to your park information. You facilitate their work with great benefit to the park. We probably have a backlog of $20,000,000 worth of research and resource management needs. If we can get them in, help them do the research, and leverage a half-million dollars a year or whatever, we're starting to lower that backlog. The second concept is that students or our staff would work side by side with researchers and there would be a learning component. You would get these school kids hooked and, over time, build the next generation of scientists. There are five prototype learning centers now: Point Reyes, Cape Cod, Great Smoky Mountains, Rocky Mountain, and Kenai Fjords in southern Alaska. We're hoping to have money to add five to ten per year over the course of the Natural Resource Challenge, which goes to 2005. If we get 32 centers across the country funded and working together it's a great vision for moving natural resource stewardship forward.

Q. Does it involve housing?
A. Yeah. One of the biggest problems we have in Marin County is that housing is way too expensive. If you want a grad student that's just barely surviving to do research in your park, you've got to provide housing.

Q. When will your facility be ready?
A. We're taking a former historic complex and rehabilitating the buildings; you know, wiring them for GIS and Internet access, creating office space and a comfortable living situation. Over the last three years, we have had to upgrade the sewage treatment facilities. We still need about $80,000 to finish up the classroom. But we've got public and private support. We're pretty close. We hope to inaugurate it in fiscal year 2001.

Q. Your park is one of 13 units in the Golden Gate Biosphere Reserve. What significance does this designation hold for your operation?
A. All of us know that parks will never survive as islands, that our resources are integrated into regional ecosystems and, for air and water, broader systems. The biosphere reserve designation gives us a higher status internationally and it encourages us to work cooperatively with the other entities that are part of the biosphere. We meet on a regular basis and look at joint programs like controlling exotic species or coho salmon restoration. We're also trying to look at the offshore systems. California right now has major problems with overfishing and degradation of coastal and offshore resources in general. So, we're trying to work with the Gulf of the Farallones National Marine Sanctuary, which is part of the biosphere, too. The biosphere helps us focus on a larger context and create partnerships; it's really good for that purpose.

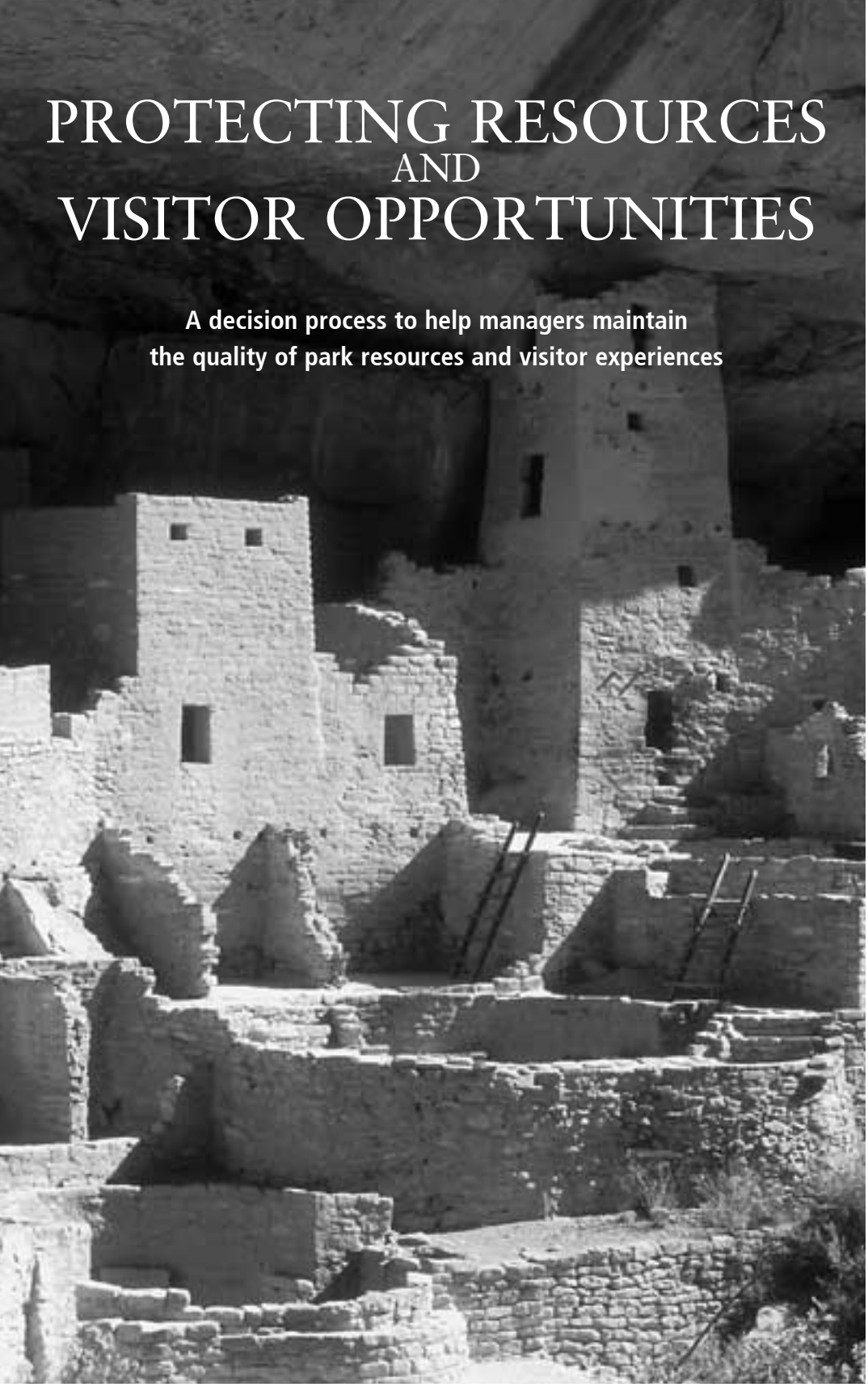
Q. What does the restoration of coho entail?
A. A number of streams drain into Tomales Bay and we've got a major effort going to restore them. We had a lot more fish at one time, but this land was all ranched heavily. There are a lot of dams and stock ponds that we hope will all be removed. Our system is still pretty intact even though there are dams outside the park that won't ever allow the populations to get back to historical numbers.

Q. You're a central figure in the implementation of the Natural Resource Challenge. How's this going?
A. It's interesting that this coincided with the millennium. We started the Challenge in 2000 and it goes to 2005. The real test was whether we could actually generate some funding, and we got approximately $15 million to launch the Challenge in fiscal year 2000. In FY 2001, we had about $18½ million in the President's budget and received about $16 million in funding. The Department has been very supportive and Deny Galvin, Mike Soukup, Bruce Sheaffer, Abby Miller, the Director, and others have done a great job of getting broad-based support. But we could lose it at any moment if we don't keep the momentum heading in the right direction. We have to make sure that we're accountable for the money being spent well. I'm very optimistic. I think that $100 million in funding and new staff could actually change the culture of the Park Service toward more resource stewardship.

Q. What do you hope to accomplish regarding resource preservation while at Point Reyes?
A. I'm fully committed to ensuring that the Natural Resource Challenge is implemented. I think it's ours to lose, and we need to make sure that across the nation there is continued support for this initiative. I really want to accomplish that. The other thing I'd like to do is ensure that parks have the right staffs to make the right decisions. Often superintendents get so focused on their own area they forget it's okay if somebody else gets money. I'm hoping that five or ten years from now we can say that we systematically enabled these parks to become environmental leaders. PS

PROTECTING RESOURCES AND VISITOR OPPORTUNITIES

A decision process to help managers maintain the quality of park resources and visitor experiences



Conducted at Mesa Verde (shown here), Yellowstone, and Arches National Parks, the study helped park managers understand and apply a broadly applicable, yet focused, decision-making process that identifies and remedies unacceptable impacts to resource conditions and visitor experiences in parks. The field tests at these parks allowed researchers to understand the challenges managers face and the skills they employ during problem solving. PHOTOS BY JEFF SELLECK

By
Theresa L. Wang,
Dorothy H. Anderson, and
David W. Lime

Introduction

The National Park Service has a mandate to protect natural and cultural resources while providing quality visitor experiences. This has never been an easy task, yet today the task is made more challenging because of increasing visitation, deferred maintenance, shrinking budgets, cumulative resource impacts, and expanded public participation. Managers frequently deal with such problems as trail deterioration, litter, wildlife displacement or habitat loss, unacceptable levels of crowding at attraction sites, and noncompliant visitor behavior. When managers face such visitor use problems, they are often uncertain about what decision-making process to use to address these impacts, or even what their problem-solving options are.

An important goal of technological innovation in the field of recreation resource management has been to help managers preserve the ecological and cultural integrity of recreation settings while providing the recreation opportunities that visitors desire. Important recreation resource management innovations developed thus far include:

- The Recreation Opportunity Spectrum Planning System (ROS) (Brown et al. 1978; Driver and Brown 1978; Clark and Stankey 1979)
- The Limits of Acceptable Change System for Wilderness Planning (LAC) (Stankey et al. 1985)
- Managing Wilderness Recreation Use: Common problems and potential solutions (A problem-solving handbook) (Cole et al. 1987)
- Visitor Impact Management Planning Framework (VIM) (Graefe et al. 1990)
- Benefits-based Management (BBM) (Driver 1994)
- Visitor Experience and Resource Protection Planning Process (VERP) (Hof et al. 1994)

For the most part, these innovations represent comprehensive planning and management frameworks. Taken together, they suggest a generalized planning process that includes articulating acceptable resource and experiential conditions, establishing management zones, selecting indicators and standards, monitoring resource and experiential conditions, identifying discrepancies between *actual* and *acceptable* conditions, and, finally, taking steps to bring actual conditions in line with what is acceptable. This "final" stage in the planning process is the one in which managers devise action plans to address specific impacts to resource conditions and visitor experiences. It is also the stage at which decision making often flounders. Thus, managers need a decision process that:

- Assists in specifying the scope, severity, and cause of the problem
- Facilitates the identification of a range of possible solutions
- Encourages an in-depth assessment of alternatives
- Strengthens the political credibility of the decision process
- Provides a resource for resolving conflicts between stakeholder groups
- Enables managers to fulfill the NPS mandate of use and preservation

The purpose of this study was to develop a decision process to address unacceptable impacts to resource conditions and visitor experiences in recreation areas.

Developing a decision process by managers for managers

The study incorporated a qualitative approach that engaged manager-participants in a series of hands-on, group decision-making sessions. The qualitative approach allowed participants to actively contribute to the development of the decision process and enabled researchers to deal with problem-solving obstacles as they emerged. Since there is no one "right" way to design a decision-making process, researchers attempted to identify and implement those features that managers agreed upon with regard to process content and flow. A modified focus group or nominal group process and participant observation were employed as the principal data collection methods. Decision-making sessions were also tape-recorded.

Thirty-two people participated in the study. Participants were divided into three groups and group size ranged from 10–12 people. Field tests were conducted at Arches, Yellowstone, and Mesa Verde National Parks from January through April, 1997. Each field test lasted 2–3 days. Participants were drawn from Arches, Canyonlands, Grand Tetons, Mesa Verde, Theodore Roosevelt, and Yellowstone National Parks; the Bureau of Land Management's Moab District in Utah and Farmington District in New Mexico; and a local "Friends" group. Participants met together regularly to discuss and make park management decisions. Participants also worked in an area for which several unacceptable impacts to resources and visitor experiences had been identified. Further, participants were able to articulate acceptable conditions, or indicators and standards, for the unacceptable impacts they had identified.

During the field tests, managers engaged in a decision process with real-life implications and were encouraged to follow whatever decision-making steps and strategies made sense to them. Three decision-making worksheets and a decision-making handbook were available as problem-solving resources. However, managers were free to use the supporting materials at their own discretion. A half-hour *debriefing session* immediately followed each decision-making session. The debriefing session was necessary to elicit manager perceptions about the decision process. During the debriefing sessions, managers frequently identified the decision-making obstacles they had encountered and suggested how to restructure the decision process and supporting materials to eliminate these pitfalls.

Developing the decision process

The field tests allowed researchers to understand the challenges managers face and the skills they employ during problem solving. The field-testing process identified five steps that are essential to solving visitor use problems. This five-step process, together with a companion handbook and worksheets, comprises a decision process to maintain the quality of park resources and visitor experiences. The five decision-making steps are outlined in table 1. The steps include: problem awareness, problem specification, strategy and tactic selection, plan implementation, and monitoring. Although these steps were perceived to be critical to overall success, managers still struggled with the best way to accomplish each task. Of the five problem-solving steps, two steps received the most attention during the field tests: *problem specification* and *strategy and tac-*

tic selection. Many improvements were made to the decision process and supporting resources to guide managers through these two critical steps.

Table 1.
Steps in the decision process to maintain the quality of park resources and visitor experiences

Step 1 *Problem Awareness*	Recognize that unacceptable impacts exist and must be addressed
Step 2 *Problem Specification*	Identify impact Describe acceptable impact levels Describe existing impact levels Determine if existing impact is unacceptable Identify root cause of impact
Step 3 *Strategy and Tactic Selection*	Select appropriate strategy Identify potential tactics Evaluate and select appropriate tactics
Step 4 *Plan Implementation*	Develop implementation plan for selected management tactics Identify specific management actions Identify person responsible for carrying out management actions Implement actions
Step 5 *Monitoring*	Monitor Effectiveness of actions If problem arises, return to problem specification stage

Problem specification

During problem specification, managers focused on an area for which they had identified one or more problems and specified acceptable resource and experiential conditions for that area. Then they determined whether there was a discrepancy between *existing* and *acceptable* conditions. Specifying acceptable conditions is equivalent to identifying the "line" that resource conditions and visitor experiences cannot cross. For example, managers may specify that during peak hours 80% of the visitors should encounter no more than 10 people (singly or in groups) on a specific quarter-mile stretch of trail. If more than 10 people are encountered more than 20% of the time along that stretch of trail during peak hours, then conditions are not within acceptable limits and managers must take action.

At Arches, managers had previously completed the VERP planning process (see *Park Science* 14(1):11–13 and 15(3):9,13). Therefore, during problem specification they referred to previously defined indicators and standards of acceptable conditions. For example, in attempting to address the problem of overcrowding at the Devil's Garden parking area, the following discussion ensued (Arches, researcher field notes, p. 4):

Participant E: [What is the] associated indicator and standard?

Participant D: 150 cars is the [estimated] acceptable limit.... The social standard is 20 persons at one time (PAOT) on a section of trail to Landscape Arch and 10 PAOT to Double "O" [Arch]. Beyond Double "O" it's 5 parties/hour.

Participant A: How many parking spaces [are presently available]?

Participant D: 35 marked spots.

Participant E: A parking lot with 150 slots is desirable.

Participant D: Currently on busy weekends we have 235–250 cars parked there. We want to be in standard 90% of the time, but [we are] only in standard 76% of the time.

Managers at Arches had a good understanding of the conditions they were trying to achieve at various areas within the park. Their extensive use of VERP standards suggests that having gone through the VERP process helped them in identifying acceptable conditions and determining whether existing conditions were within acceptable limits.

At Yellowstone and Mesa Verde, managers determined acceptable conditions based primarily on manager perceptions. Although managers at Yellowstone had previously completed a VERP planning process to address winter use in the park, the problems they addressed during the field test fell outside the scope of earlier planning efforts. This approach lacked the rigor of specifying indicators and standards, but it drew upon considerable manager experience with an area over time. A lack of visitor and resource data hindered decision making, but the decision process helped to pinpoint the specific information managers needed. In fact, one manager at Yellowstone commented, "This process will trigger monitoring."

In general, managers felt that the problem specification portion of the process was helpful in their decision making. Although managers recognized the value of defining the problem, they tended to struggle with problem specification. In some cases managers glossed over this portion of the process in their haste to engage in brainstorming and tactic selection. At other times they defined the problem too broadly, failed to clearly specify the timing or location of the problem, or neglected to conduct an in-depth analysis of all the possible causes of the problem. One of the researchers analyzed *why* managers struggle with problem specification: "Once people start asking

'why,' the 'problem' begins to change. This is probably good, but maybe this 'backing up' ought to be recorded if for no other reason than to keep track of the path they followed to move from problem Z to problem A" (Mesa Verde, researcher field notes, p. 2).

Field test results suggest that problem specification is more complicated than it appears, and that what actually constitutes the "problem" may be a moving target—with definitions changing as the analysis proceeds. Based upon field test results, the decision process and supporting materials were modified to ensure that managers do not jump ahead to considering solutions before they have articulated the scope, severity, and cause of the specific problem they are addressing.

Strategy and Tactic Selection

The brainstorming portion of the process requires managers to identify strategies and tactics that are appropriate to the specific problem being addressed. Managers felt the decision process and supporting materials helped them to generate a range of possible solutions and think "outside of the box."

The decision process … [was] modified to ensure that managers do not jump ahead to considering solutions before they have articulated the scope, severity, and cause of the specific problem….

Field test results revealed a number of factors that either facilitate or inhibit brainstorming. Managers found brainstorming to be more effective when they jumped around, discussing tactics in a free-flowing manner. When managers considered tactics methodically, as if going through a lengthy checklist from top to bottom, the process felt overly tedious. During brainstorming, discussions frequently incorporated dialogue about specific management actions that could be developed for a tactic and the advantages and disadvantages of a potential tactic. One researcher felt such discussion "was generally good and may enhance products" in the next stage of the process. Facilitators play an important role during brainstorming by ensuring that some tactics are not discussed in too great of depth while other tactics are ignored.

Field test results also revealed an interesting brainstorming dilemma. To avoid getting bogged down, the process requires managers to focus on a *specific* problem at a *specific* location. However, this site-specific focus can inhibit brainstorming by limiting the consideration of tactics that would be most effective if conducted on a *park-wide* basis. Consider the following interaction between managers at Arches (Arches, researcher field notes, p. 10–11):

Participant H: [I don't] see visitor education at Windows [as mandatory]. It must be park-wide but [I don't] know how it would be done with the hundreds of thousands of visitors.

Participant D: [We could] revisit queuing [and] reservations because indirectly [these approaches] would [address the problem] at Windows if we did [employ them] park-wide.

Participant C: Interesting comment. We should [record] that reservations, queuing, and visitor education are "maybe's;" they're "yes's" if done park-wide.

If managers had ruled out visitor education, queuing, and reservations as potential tactics simply because it seemed like too much work for a single location, and if managers failed to consider park-wide options, the potential effectiveness of these tactics at addressing site-specific problems might have gone unnoticed.

Tactic selection requires managers to assess the relative merits of various tactics. At Arches, one manager asked, "How do you answer the question 'Is this the best way to fix the problem?'" Managers used a wide variety of criteria to select tactics for implementation including park purpose, cost to visitors, manager expertise, legal compliance, off-site impacts, and economic feasibility, just to name a few. Although the decision process includes supporting materials to assist managers with tactic evaluation, improving this part of the decision process is an important direction for future research. Based on field test results, the decision process and supporting materials were modified to facilitate manager consideration of a variety of strategies and tactics. Modifications were also made to facilitate documenting the results of discussion and recording the reasons why specific tactics were selected. When managers consider a wide variety of options and document the reasons behind a chosen course of action, the political credibility of the decision process is strengthened.

Conclusion

This article outlines a decision process to maintain the quality of park resources and visitor experiences and highlights the contributions managers at Arches, Yellowstone, and Mesa Verde made to the development of the decision process. Technological innovation in the field of recreation resource management benefits from extensive manager involvement in the development process. By working closely with managers researchers were able to (1) better understand the process managers use to solve visitor use

problems and (2) develop a decision process and supporting materials that managers find useful and user-friendly. To increase the quality of recreation resource management decision making, and to ensure that improvements in decision making can be replicated across the national park system, managers need decision-making frameworks, tools, and processes. This research project developed a decision process, handbook, and worksheets to help managers solve visitor use problems.

The decision process and handbook build upon previous research by Cole, Petersen, and Lucas (1987); Cole (1989); and Graefe, Kuss, and Vaske (1990). This effort's most important contribution, however, may be in developing a process in which managers use worksheets to specify their most critical problems and to identify alternative management tactics to address these problems. The decision process can be used by managers who have implemented comprehensive planning frameworks, such as LAC, VIM, and VERP; however, it will also improve visitor use problem solving among managers who have not implemented these comprehensive planning processes.

> When managers consider a wide variety of options and document the reasons behind a chosen course of action, the political credibility of the decision process is strengthened.

The decision process to maintain the quality of park resources and visitor experiences, and the companion handbook and worksheets, are available from the University of Minnesota, Cooperative Park Studies Unit (1530 N. Cleveland Ave., St. Paul, MN 55108) and the Denver Service Center (c/o Marilyn Hof, National Park Service, 12795 W. Alameda Parkway, Lakewood, CO 80225-0287). PS

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LATE JURASSIC (MORRISON FORMATION) CONTINENTAL TRACE FOSSILS FROM

CURECANTI

NATIONAL RECREATION AREA, COLORADO

By Anthony R. Fiorillo and Richard L. Harris

Curecanti National Recreation Area encompasses the eastern portion of the Black Canyon of the Gunnison and shares a common boundary with the Black Canyon of the Gunnison National Park in west-central Colorado. The park contains three dams comprising the Wayne N. Aspinall Unit of the Upper Colorado River Storage Project. The largest reservoir created by the dams, Blue Mesa Lake, serves as a major recreational resource for fishermen and boating enthusiasts.

Geologically, the park is recognized for having exposures of rocks that date to over 1.7 billion years in age, making these rocks among the oldest in western North America. In addition to these well recognized resources, Curecanti National Recreation Area also contains fossil resources that have significant scientific and educational value. The most important of these fossil finds is in the Upper Jurassic Morrison Formation in the park (fig. 1).

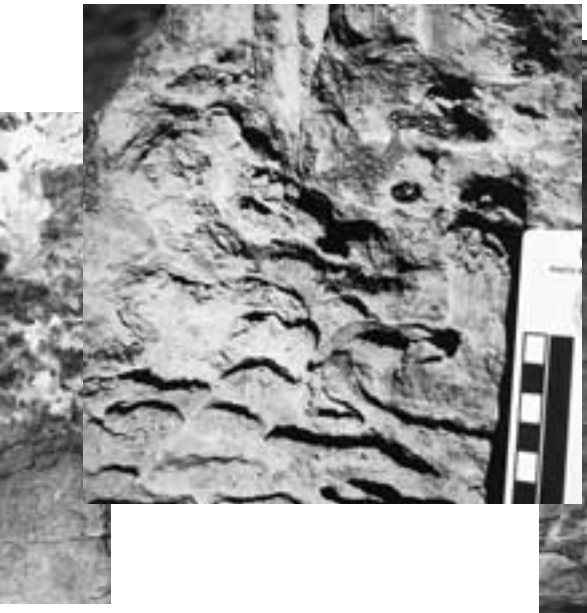
Perhaps most significant of these fossil finds is the discovery of a quarry, which has been discussed elsewhere (Fiorillo et al. 1996; Fiorillo and May 1996), containing the remains of at least two dinosaurs. Excavation of this fossil site continued for three years, and the preparation of the fossil material continues. Continued surveying of the paleontological potential within this park has shown that the Morrison Formation is rich in other fossil resources as well. We briefly report here the occurrence of various fossil traces of invertebrates also from the Morrison Formation, described in more detail elsewhere (Fiorillo 1999), and describe the management, education, and exhibit uses of these important newly discovered resources. These additional sites, along with the previously described dinosaur quarry, emphasize the point that significant management issues may include resources not traditionally recognized within individual parks (see *Park Science* 16[4]:14–15). Further, like the great diversity in the types of remains found in the fossil record, there is also diversity in management techniques that can be employed to document these occurrences. Finally, park visitors are interested in learning about natural resources, including park paleontology. In a telephone conversation on 6 November 2000 with the second author, Gary Machlis, the NPS Visiting Chief Social Scientist, agreed with this assertion. He noted that there are many examples from surveys of park visitors conducted under the Visitor Services Project that show that information about park resources, including natural resources, is an important and highly sought after service provided by the National Park Service.

> Perhaps most spectacular of these fossil traces are the remains of ancient termite nests.

BACKGROUND

The Morrison Formation of the western United States has produced the vast majority of the Jurassic dinosaurs from North America; hence, most of the paleontological work on this fossil unit has focused on fossil vertebrates, particularly dinosaurs. This important fossil unit, composed largely of ancient stream, floodplain, and lake deposits, is found at the surface or in the subsurface from Montana to New Mexico and from Oklahoma to Utah. The youngest part of the Morrison Formation is the Brushy Basin Member, which is the source of most of the vertebrate remains from this formation. Underlying the Brushy Basin Member is the Salt Wash Member of the Morrison Formation. The age of this formation has traditionally been considered to be Late Jurassic. Historically climatic interpretations for Morrison Formation deposition range from wet to dry, and most specialists have invoked a strong seasonality during Morrison times.

A new dinosaur locality was discovered in the Morrison Formation during recent paleontological fieldwork at Curecanti National Recreation Area and Black Canyon of the Gunnison National Park (Fiorillo et al. 1996; Fiorillo and May 1996). Continued survey of these parks has pro-



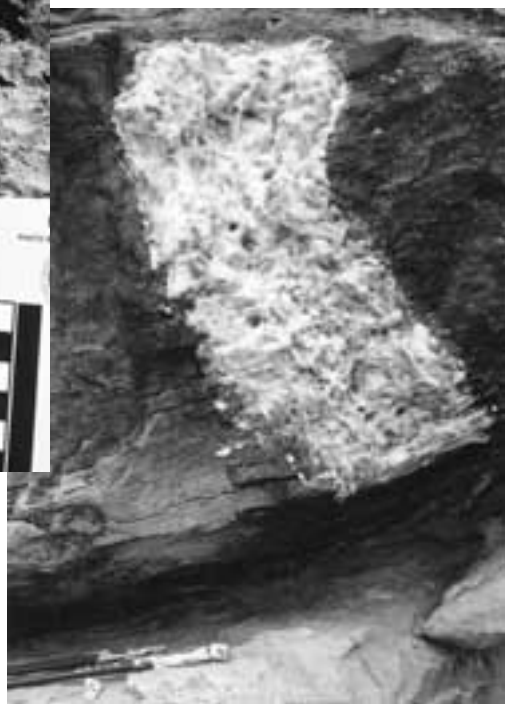


Figure 1 (clockwise from far left). Exposures of the fossil-rich Morrison Formation are evident in this view of the West Elk Arm of Blue Mesa Lake in Curecanti National Recreation Area. These shoreline exposures are very low, and therefore old, in the layering sequence of the Morrison Formation section.

Figure 2. Placed for scale, the handle of a rock hammer runs alongside a Jurassic termite nest from a Morrison Formation exposure in Curecanti National Recreation Area. Notice the pattern of chambers in the nest.

Figure 3. Modern Spinifex termite nest from Western Australia. Notice the similarity in pattern of chambers in this nest compared to the fossil nest in figure 2.

Figure 4. Impractical to move because of its size and weight, the recently discovered Jurassic termite nest was left in situ where paleontologists coated the fossil (shown in figure 2) with latex. The resulting "peel" is used as a mold to cast the fossil in plaster for educational and scientific needs. The paintbrush at the bottom provides scale.

vided new insights into the trace fossils within the fluvial, or stream channel and floodplain, portions of the Morrison Formation, and the overall Jurassic paleoecosystem within these parks. Trace fossils are typically defined as fossilized equivalents of the structures produced in rocks, sediments, and grains by the life processes of organisms, with the study of these features referred to as ichnology (Bromley 1996). The most common trace fossils include burrows and footprints.

LOCAL SETTING

Several types of invertebrate trace fossils have now been identified in the upper part of the Morrison Formation of Curecanti National Recreation Area. These trace fossils record important information regarding the paleohydrologic and paleoecologic setting of this fossil unit in this park. Hundreds of traces occur in fluvial sandstone and mudstone deposits. The traces include crayfish burrows, termite nests, homopteran (an insect order that includes cicadas and aphids) burrows, bee cells, and earthworm burrows (Fiorillo 1999; Fiorillo and Hasiotis 1996). Also present are various sizes of rhizoliths, or plant root traces (Fiorillo and Hasiotis 1996). The invertebrate trace fossils predominantly occur in sandstones, whereas the plant root traces can occur in either the mudstones or the sandstones. Stratigraphically, these fossil traces appear to be confined to the lower part of the Brushy Basin Member or the upper part of the Salt Wash Member of the Morrison Formation. Perhaps most spectacular of these fossil traces are the remains of ancient termite nests (figs. 2 and 3).

The distribution and shape of these traces are related to paleoenvironmental conditions such as variations in water table and soil moisture levels that these burrowing organisms experienced during the Late Jurassic. For example, the length of the crayfish burrows delineates the depth of the water table level. The traces in Curecanti National Recreation Area with the greatest vertical component are the termite nests, which occur within the confines of large fossil root traces. The restriction of this ichnofossil to within a few meters of the Salt Wash/Brushy Basin contact suggests a time of greater aridity during the highly seasonal climate than in other portions of the Morrison Formation in the park.

MANAGEMENT ISSUES

The occurrence and distribution of these trace fossils has scientific importance, as well as public education potential. These fossils are largely located along the shores of the Blue Mesa Reservoir in Curecanti National Recreation Area, in large sandstone blocks that weigh in excess of 1,000 pounds each. Given the logistical difficulty in moving such large blocks, or alternatively, attempting to utilize diamond-bladed rock saws to cut the fossils of interest out of the sandstone, it was deemed most appropriate to follow a third alternative. This third alternative was to produce latex peels of select fossil features. These peels would then be used as molds for making plaster casts that can be used for educational and exhibit needs.

One example of such a process for making a peel of a termite nest is illustrated in figure 4. This particular termite nest shown in this figure has been subsequently cast in plaster, painted, and used as part of a highly successful exhibit entitled "Six Legs Over Texas: the infestation continues" at the Dallas Museum of Natural History.

See "Curecanti" in right column on page 35

AN IMPORTANCE-PERFORMANCE EVALUATION OF SELECTED PROGRAMS IN THE NATIONAL CENTER FOR RECREATION AND CONSERVATION

By Michael A. Schuett, Steven J. Hollenhorst, Steven A. Whisman, and Robert M.Campellone

In 1998, the National Center for Recreation and Conservation (NCRC) of the National Park Service, with West Virginia University, conducted a study to assess satisfaction of NCRC cooperators, in compliance with the Government Performance and Results Act (GPRA). The NCRC surveyed its cooperators in the following programs: (1) Rivers Trails and Conservation Assistance (RTCA), (2) National Heritage Areas (NHA), (3) Federal Lands-to-Parks (FLP), and (4) Wild and Scenic Rivers (WSR) programs. The RTCA program helps communities plan greenways, conserve rivers, and develop new trails through voluntary partnerships that emphasize local ownership and involvement. The NHA program advises community leaders in 18 National Heritage Areas on partnership strategies for conserving cultural and natural resources. The FLP program helps state and local agencies acquire, at no cost, surplus federal land and facilities for parks and recreation. The WSR program is responsible for the management of four wild and scenic "partnership" rivers. This program is responsible ensuring resource protection and partnership goals are met.

The items of highest importance among RTCA cooperators received the highest satisfaction scores.

Purpose and study design

The purpose of the study was to assess the level of satisfaction among "cooperators" who had received a "substantial" level of assistance or services from the four NCRC programs during the 1998 federal fiscal year. Survey recipients were "primary contacts" for each project and primary cooperator organization that received assistance or services from the respective NCRC programs. Each program established criteria unique to their particular set of services to define substantial levels of assistance.

An Importance-Performance (I-P) technique was used. The assistance activities of each NCRC program were segmented into specific elements for which the importance and satisfaction ratings among served cooperators were elicited. The basic assumption underlying the I-P technique is that overall program satisfaction is an aggregate of the satisfaction level for each program element relative to its importance. By acquiring meaningful feedback on the importance and performance of each program element, the NCRC could better target its efforts in meeting long-term performance goals.

Each NCRC program developed a list of elements, and given the unique purposes of each program, it was clear that a different list was required for each program. While many elements were applicable to all four program questionnaires (e.g., assistance with developing a vision, mission, goals, and action plans), other items applied specifically to only one or two programs. The elements were arrayed in a question set for which respondents were asked to assess in terms of the importance of each to their project, and their level of satisfaction with the delivery of each item. A five-point Likert scale was used to rate the level of importance (1 = Very Unimportant, 5 = Very Important) and satisfaction (1 = Very Dissatisfied, 5 = Very Satisfied).

The I-P approach identifies priorities for each element of each of the evaluated programs contingent upon the element's position in a four-quadrant matrix. The "Keep Up the Good Work" quadrant includes program elements cooperators rated as highly important to their particular project, and also rated highly in terms of their satisfaction with the program's delivery of those elements. The "Concentrate Here" quadrant contains elements of high importance to cooperators but on which the program's performance was low. Program elements of low importance to cooperators but were well delivered fall into the "Possible Overkill" quadrant. Finally, the "Low Priority" quadrant contains items that were of low importance but

for which cooperator satisfaction levels were comparatively low.

The study represents a census survey of all program cooperators, thus a questionnaire was mailed to each. Databases were obtained from each program group that included the names, mailing addresses, and various types of program information. The program populations included 162 RTCA cooperators, 11 NHA cooperators, 4 WSR cooperators, and 87 FLP cooperators. Population sizes, responses, and actual response rates for each program are shown in table 1. The first mailing was sent in November of 1998. In order to attain the target response rate, follow-up reminders and a second mailing were sent out on a schedule prescribed by Dillman. The cutoff date for returned questionnaires was April 15, 1999. Response rates, which ranged from 80% for FLP to 100% for WSR, are considered excellent by all estimations and criteria (Dillman 1978). Table 2 on page 32 lists the assistance activities of each NCRC program that were evaluated; the number for each activity corresponds to the numbered data plotted in figures 1–4.

Table 1.

National Center for Recreation and Conservation GPRA Survey: Population Size, Responses, and Response Rates.

Program	Population Size	Responses	Response Rate
RTCA	162	143	88%
FLP	87	70	80%
NHA	11	9	82%
WSR	4	4	100%

Findings

Rivers, Trails, and Conservation Assistance Program

In general, a strong positive relationship (r=0.74) was observed between importance and satisfaction scores for RTCA program elements (figure 1). In other words, the items of highest importance among RTCA cooperators received the highest satisfaction scores. From a service delivery perspective, this indicates a visceral understanding among RTCA personnel about which program elements are most important to cooperators, and thus they have developed their capacity for excellence in these areas. Conversely, the program performed least well on elements of least importance, indicating program efficiency by not wasting resources on elements unimportant to cooperators.

Generally, elements of highest importance and satisfaction tended to relate to organizational development and capacity building, while less important and less well delivered items related to information and evaluation of resources. Program elements in the Keep Up the Good Work quadrant of the I-P matrix included: developing a vision, mission, and goals; ensuring support and involvement from relevant interest groups; assuring support from the community; facilitating meetings; providing information about the experience of other groups; guidance in developing publications and graphic materials; and fulfilling commitments made to the project.

Three items were rated highly important, but did not receive high satisfaction ratings. Items in this Concentrate Here quadrant included: developing the capacity of the organization; providing information on trail development; and helping to secure possible funding sources.

Five items relating to provision of information were rated in the Low Priority or Possible Overkill quadrants. This suggests that relative to the other program services offered by RTCA, providing information (items 7, 9, 10, 11, 12) was seen as neither a high priority nor particularly well delivered. It appears that RTCA cooperators may look to other sources of information while appreciating the one-on-one assistance RTCA can provide them in developing the direction and capacity of their organizations. Other items that fall into these quadrants include site evaluation (6) and overcoming problems and crises (16). The fact that only one item—provision of information on interpretation and education—fell into the Possible Overkill quadrant again suggests that the agency has done a good job at not devoting a disproportionate of resources on low priority items.

Federal Lands-to-Parks

A moderately strong positive correlation (r=0.57) was found between importance and satisfaction scores for FLP services (figure 2, page 33). While the program is doing a

Figure 1. Rivers, Trails, and Conservation Assistance Program

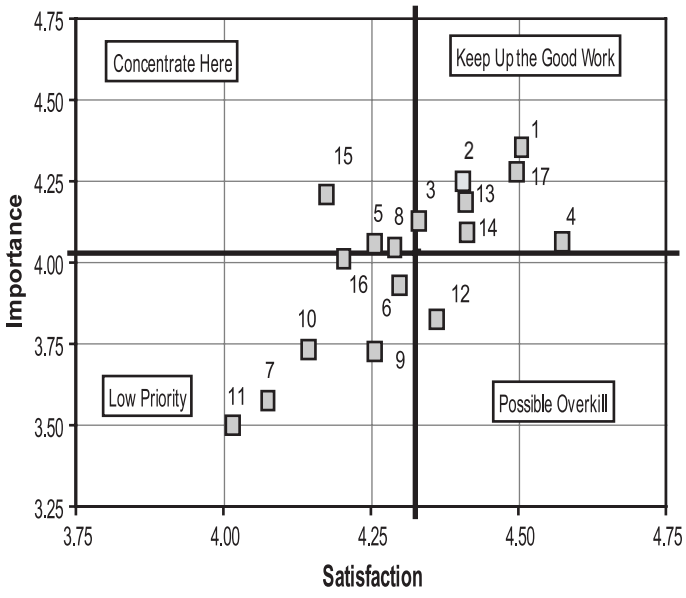
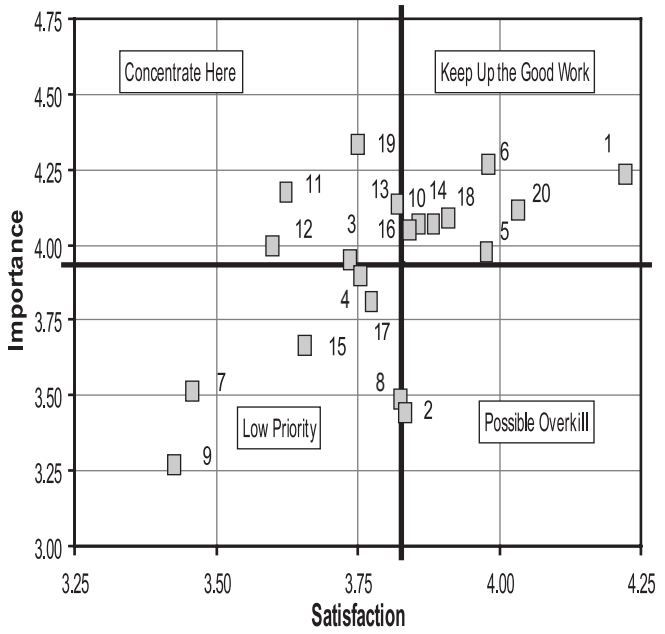


Table 2.
Importance-Performance Quadrants for Four Programs in the National Center for Recreation and Conservation

	Rivers, Trails, and Conservation Assistance	Federal Lands-to-Parks	National Heritage Areas	Wild and Scenic Rivers
Keep Up the Good Work	4 Assistance with facilitation of meetings 1 Assistance with developing a vision, mission, goals, or action plan 17 Fulfilling the commitments made to the project in a timely manner 13 Providing information about the perspectives and experiences of other organizations with similar projects 14 Guidance on developing publications and graphic materials 2 Ensuring support and involvement from relevant interest groups, officials, and organizations 3 Assuring support from the community	1 Assistance with understanding the procedures, requirements, and general process of the FLP Program 20 Availability and extent of involvement by FLP staff 6 Communicating stewardship requirements, processes, or issues 5 Providing information on points of contact and other related agency programs 18 Overcoming unexpected problems, obstacles, or crises 14 Assistance in developing or reviewing third-party operating or use agreements 10 Assistance in preparing FLP application materials 16 Assistance in promoting and supporting your proposal with other agencies or organizations	6 Administering federal funds made available to your NHA 10 Fulfilling NPS commitments made to the project in a timely manner 1 Providing technical information about heritage area development 5 Involving other organizations and agencies that can assist your NHA 3 Helping your organization develop annual and long-range work plans	16 Overcoming unexpected problems, obstacles, or crises 14 Guidance on developing publications and graphic materials 15 Identifying, suggesting, or helping to secure other possible funding sources 17 Fulfilling the commitments made to the project in a timely manner
Concentrate Here	8 Providing information on trail development 5 Assistance with developing the capacity of your organization to undertake the project 15 Identifying, suggesting, or helping to secure other possible funding sources	13 Assistance with proposed changes in land use for acquired properties 19 Fulfilling the commitments made to the project in a timely manner 3 Identification of and notification about available property 11 Preparing property deeds and transferring property 12 Assistance in modifying or enhancing acquired properties	7 Identifying, suggesting, or helping to secure possible funding sources	5 Assistance with developing the capacity of your organization to undertake the project 6 Identifying or evaluating natural, cultural, historic, and recreational resources that are worthy of protection, restoration, or interpretation 9 Providing information on river conservation 12 Providing information on interpretation and education 7 Providing information on protection strategies for natural resources 10 Providing information on open space protection 11 Providing information on protection strategies for cultural resources 13 Providing information about the perspectives and experiences of other organizations with similar projects
Low Priority	6 Identifying or evaluating natural, cultural, historic, and recreational resources that are worthy of protection, restoration, or interpretation 9 Providing information on river conservation 16 Overcoming unexpected problems, obstacles, or crises 10 Providing information on open space protection 7 Providing information on protection strategies for natural resources 11 Providing information on protection strategies for cultural resources	8 Assistance in developing justification for parks, recreation, or conservation 17 Adding credibility to your project with other agencies or organization 4 Providing information on land acquisition or military base reuse processes 15 Assistance in considering alternative methods or strategies for achieving objectives 7 Identifying or evaluating natural, cultural, historic, and recreational resources on the property that are worthy of protection, restoration, or interpretation 9 Assistance in planning the use of property for public use	12 Providing information about the perspectives and experiences of other organizations with similar projects 2 Fostering nonfinancial growth and development of your organization 11 Overcoming unexpected problems, obstacles, or crises	1 Assistance with developing a vision, mission, goals, or action plan 3 Assuring support from the community 8 Providing information on trail development
Possible Overkill	12 Providing information on interpretation and education	2 Assistance with developing a vision, mission, goals, or action plan	9 Assistance with developing publications and graphic materials 4 Providing information about other federal programs that can assist in NHA protection and development 8 Identifying or evaluating natural, cultural, historic, and recreational resources that are worthy of protection, restoration, or interpretation	4 Assistance with facilitation of meetings 2 Ensuring support and involvement from relevant interest groups, officials, and organizations

Figure 2. Federal Lands to Parks Program



good job of developing excellence in areas of highest importance to their cooperators and de-emphasizing items of low importance, six items fell in either the Concentrate Here or Possible Overkill categories. This suggests that for nearly a third of the program elements, the organization is not dedicating sufficient attention or is supporting the element beyond its importance.

In many ways, the FLP findings are in stark contrast to RTCA, suggesting a far different clientele with different service priorities. Unlike the results for RTCA, FLP cooperators seem most interested in, and were most satisfied with assistance they received regarding the "nuts and bolts" of the project. For example, items in the Keep up the Good Work quadrant included: assistance with understanding procedures, requirements, and general processes; providing information on points of contact and other related agency programs; communicating stewardship requirements, processes, and issues; preparation with application materials; development or reviewing third-party operating or use agreements; promoting or supporting the proposal with other agencies; overcoming unexpected problems and crises; and availability and extent of involvement by FLP staff.

The Concentrate Here quadrant also contained items related to the specifics of project completion: identification of and notification about available property; preparing property deeds and transferring property; modifying or enhancing acquired properties; assistance with proposed changes in land use for the properties; and fulfilling the commitments made to the project in a timely manner. It appears that FLP cooperators expect the program to be both an advocate for the property transfer within the federal government and the source of technical legal help in accomplishing the transfer.

Also in contrast with RTCA was the finding of Low Priority for items relating to developing their organization or building public support for the project: developing justification for park and recreation uses of the property; building credibility for the project with other agencies or organizations; providing information on land acquisition or military base reuse processes; alternative strategies for achieving objectives; site evaluation; and planning for public use of the property.

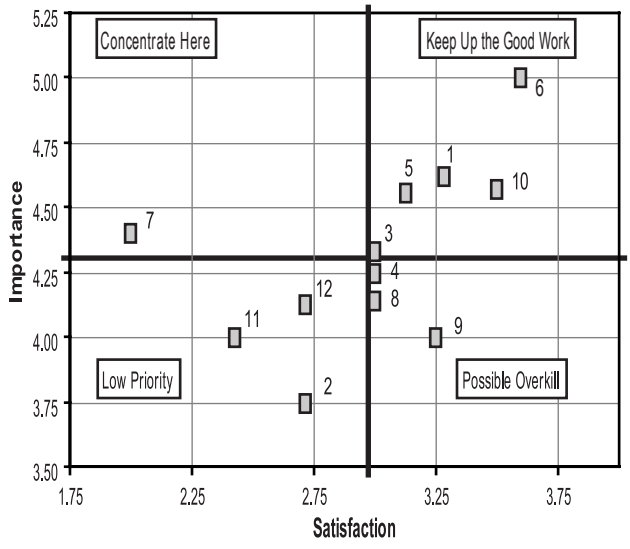
Lastly, assistance with developing the cooperator organization's vision, mission and goals were well delivered, but not viewed as particularly important, and thus fell in the Possible Overkill quadrant. FLP cooperators may have a well-defined and focused mission—acquiring a specific piece of property—and can therefore look to the organization for direct assistance in making the acquisition happen.

National Heritage Areas

In general, relatively high importance ratings among NHA cooperators suggest that the forms of assistance or services provided by the program were consistent with cooperators' priorities (figure 3). Even though the NHA program sustained the lowest mean satisfaction score of the four programs—2.97 across all program elements included in the I-P analysis—their overall results were positive.

Conversely, a moderately strong positive correlation (r=0.52) was found between importance and satisfaction ratings, with only four items falling in the Concentrate Here or Possible Overkill categories. This suggests that the organization is doing a good job at targeting resources to the most important program elements, and is not committing unnecessary resources to items of low importance.

Figure 3. National Heritage Areas Program



Five of the twelve items fell into the Keep Up the Good Work quadrant. In contrast to RTCA and FLP, these items generally relate to managing and sustaining the projects over the long term, and include: providing technical information about heritage area development; helping the organization develop annual and long-range plans; involving other organizations that can be of assistance; administration of federal funds made available to their heritage area; and fulfilling commitments made to the project.

The one item in the Concentrate Here quadrant also relates to long-term program management: securing other sources of funding. The average satisfaction score on this item was 2.0, which was the lowest for any element of all four programs. Like the other cooperators, these respondents placed a high priority on securing additional funding sources, and expressed a high level of dissatisfaction with NHA in this regard.

Three items fell into the Low Priority category: provision of information about other organizations; fostering the nonfinancial growth and development of the organization; and overcoming unexpected problems. Three items fell into the Possible Overkill category: site evaluation of resources; developing publications; and provision of information about other federal programs that may assist their project.

Wild and Scenic Rivers

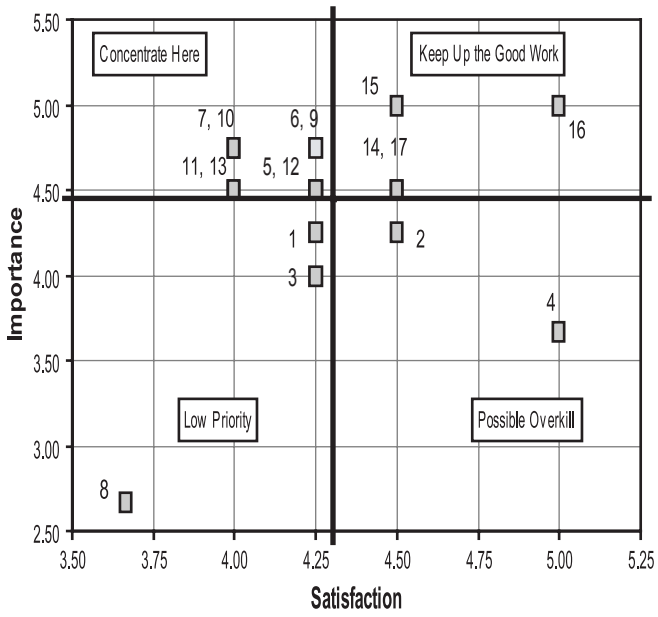
The rivers used in this study represent four "partnership rivers" served by the WSR program. These four rivers are only a small portion of 34 segments and over 2,600 miles of the Wild and Scenic Rivers System administered by the National Park Service. Because of the extremely small population size, the WSR results should be viewed with caution. Nonetheless, as a complete census of the four program participants, the findings are illuminating (figure 4).

A comparatively weak correlation (r=0.27) was observed between importance and satisfaction scores for WSR program elements. This finding could be a result from either low population size or extremely high importance and satisfaction ratings by WSR cooperators. Nonetheless, eight of the seventeen items fell in the Concentrate Here category, suggesting that the organization is not committing sufficient attention to these items.

No meaningful connection was observed among the four items in the Keep up the Good Work quadrant: guidance on developing publications; securing other funding sources; overcoming unexpected problems; and fulfilling commitments made to the project.

However, unlike the other three program groups, WSR cooperators place high importance on resource evaluation and information, but were relatively less satisfied with assistance received in these areas. Items falling into this Concentrate Here quadrant included: developing the capacity of your organization; site evaluation; providing information on protection strategies for natural resources; providing information on river conservation; providing information on open space protection; providing information on protection strategies for cultural resources; providing information on interpretation and education; and providing information on other organizations with similar projects.

Figure 4. Wild and Scenic Rivers Program



Falling into the Low Priority quadrant were: developing vision, mission, goals; building support within the community; and provision of information on trail development. Cooperators placed a low priority on trail development; however, this is a service the WSR program does not emphasize. Two items fell into the Possible Overkill quadrant: assistance with facilitating meetings and enlisting relevant interest groups.

Discussion

With few exceptions, both importance and satisfaction scores suggest a high level of support for and fulfillment of the services delivered. NCRC program staff should be congratulated for having a very good sense of the program elements important to their constituents and delivering on these items.

Of the items common across the four programs, few similarities emerged. For instance, while assistance with developing a vision and mission was viewed as important and well delivered by RTCA participants, it was seen as a low priority or possible overkill by FLP and WSR. This demonstrates the vastly different constituency needs and interests across the four programs, along with the ability of each program group to customize their services to the specific needs of their constituency.

Three of the four programs (RTCA, FLP, and NHA) viewed identification and evaluation of site resources as a low priority. Only WSR placed a relatively high value on its provision. Of the three programs that included assistance with obtaining funding as an item, two (RTCA and NHA) viewed the service as highly important, but were relatively dissatisfied with its delivery. Thus, two general recommendations are given. First, it appears that the NCRC programs should generally de-emphasize site identification and evaluation as a program service. With the exception of the WSR program, this capacity is not highly valued by constituents. Second, NCRC should place a greater focus on assisting constituents with identifying funding strategies and sources for their programs. One way this could be accomplished would be to build expertise on funding sources within the National Center for Recreation and Conservation and field offices. There are several organizations that focus on helping small nonprofits with issues related to fund-raising, grant writing, and financing. Perhaps formal relationships could be developed with these organizations for the purpose of assisting NCRC cooperators with this vexing problem.

Finally, National Park Service programs such as the NCRC are being held more accountable to the public for both the efficacy and efficiency of their operations. The Importance-Performance technique is a useful evaluation tool for disaggregating and evaluating multidimensional organizations comprised of various program delivery elements. Methods of statistical analysis are relatively simple, and are presented visually for straightforward interpretation. As such, the I-P technique has broad applicability to a wide variety of agencies and organizations. PS

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"Curecanti" continued from page 29

Similarly, casts are available to the National Park Service for its educational and exhibit needs. Further these casts provide researchers the opportunity to study accurate reproductions of these fossil features, features that would otherwise be lost due to erosion. The National Park Service has provided the logistical support and framework for the excavation while the Dallas Museum of Natural History has provided the technical expertise for the molding and casting. This partnership has produced a successful model of cooperation between the Park Service and a private institution, and has yielded important scientific, preservation, and educational results from a previously unrecognized resource. PS

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